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LIEUT. COMMANDER P. F. HARRINGTON, U. S. N., in the Chair.

THE COEFFICIENT OF SAFETY IN NAVIGATION.

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It is customary among engineers and architects, in making allowance for the strain to be borne by any part of a structure, to assign to the materials used a strength sufficient to withstand a strain much greater than that to which the structure is ever likely to be subjected. By a combination of theory and experiment it can be found, for example, what is the *breaking load* of a wooden or iron beam of given dimensions, and from the empirical law thus established we can ascertain approximately the breaking load for any beam of the same material and having the same form and dimensions; but in order to cover all possible differences which may exist among different beams, a coefficient of safety is either introduced into the formula representing the breaking load, or is applied to the result obtained from the formula. This coefficient should be large enough to cover not only the largest possible deviation between theory and experiment, but also to meet all unforeseen emergencies, such as time and age inevitably bring.

Passing now to the consideration of the term *coefficient of safety* as applied to navigation, it is our object to find the limits within which, under ordinary circumstances, a vessel can be located at sea,

and then to adduce some considerations which will enable us to form an intelligent judgment in regard to the *range of error* to which observations are liable. The quantity wanted is the average number of miles of error in latitude and longitude which we may fairly charge upon a single observation at sea under ordinary circumstances. We have then to find the coefficient by which this number must be multiplied in order to secure absolute safety, as far as safety depends upon human means and exertions. If we represent the average error by E, and the safety coefficient by P, then $E \times P$ should cover not only the range of error to which observations at sea are liable, but also those extreme cases in which a combination of causes acting in the same direction may produce errors of greater magnitude than the most prudent navigator would even suspect. We start with the average error E, in a given series of observations. It is obvious that the absolute error may be as small as the least value of the series and as large as the greatest value. A constant error may also be involved in every observation of the series, even when there are no indications of its existence. The total error therefore may be:

$$E \times P + \text{a constant.}$$

In this investigation the computed value of the coefficient P is obtained by dividing the difference between the greatest and the least values of a given series representing errors of observation by the average value.

Capt. Williams of the ill-fated Atlantic is represented by a reporter of the New York Tribune to have said that he knew the position of his ship within her length, at the time of his last observation, twelve hours before she became a wreck. If he really made that statement, no other evidence is needed of his utter unfitness for the position which he occupied. After twelve hours' run his error was twelve miles. Was that so large an error as to justify the charges with which the daily press teemed, that he had "blundered in his calculations"? In the court of investigation which followed the disaster, was the question how far it might have been allowable for him to have been in error, raised? Did the daily press raise this question? Was the question ever considered in any court of inquiry? Not as far as I can ascertain. Was this aspect of the question ever investigated at all upon any intelligent basis? If it has been, I have failed to find a record of it, after the most diligent search. In no one of

the forty-three volumes of the English Nautical Magazine, a standard authority, to which I am largely indebted in this discussion, can I find the question once raised, and I think there are few articles bearing upon the subject of wrecks which I have not consulted. In the British Admiralty laws on this subject, especially in the new code adopted in 1849, after the repeal of what is known as Huskinson's law, almost every aspect of the question is considered except this. There are regulations upon almost every conceivable point, from the constitution of courts of inquiry to the furnishing of proper lime-juice for seamen. In the Wreck Register, published annually by the British Board of Trade, to which I am largely indebted for data, not only the number, but the causes of wrecks are enumerated. A small number are attributed to the incapacity of masters, but even here there seems to have been so far no inquiry as to what constitutes incapacity in this respect. If it is a fact that navigators proceed upon the supposition that they can with certainty obtain their position by astronomical observations within one mile, to say nothing of three hundred feet, the wonder is, not that so many wrecks occur, but that more do not occur. I have said I could find no mention of this aspect of the question. Perhaps I ought to except two editorials on the loss of the City of Washington. The New York Times said: "It is believed that the captain of an ocean steamer, freighted with a priceless cargo of human life, should know at all times, in spite of fog and tempest, just where he is." To which the New York World replies, that "any one who believes such stuff as this is an idiot, and that the only way for him to find out anything about the Nova Scotia coast would be by taking command of a ship freighted, not with a priceless cargo of human life, but with a crew of cheap and congenial idiots, and required to know in spite of fog and tempest just where he was." One might almost say that the 19th century is behind the 18th in a proper appreciation of the importance of the true solution of this problem. As early as 1598, Spain offered a reward of 1000 crowns for the discovery of a correct method of finding the longitude at sea. The States of Holland, at an early date, offered a reward of 100,000 florins, and France a reward of 100,000 livres. In 1714 the British government offered a reward of £10,000 to any one who should discover a method of finding the longitude at sea within sixty miles, £15,000 within forty-five miles, and £20,000 if within thirty miles. This offer did much to awaken interest in the subject. Though we have long since passed the lowest limit then mentioned, thirty miles,

it is doubtful if any two navigators will agree as to what limit we have actually reached. The general testimony of sea-captains in answer to my inquiries upon this point, is that one mile is the ordinary limit within which the co-ordinates of a ship's place can be determined. A few placed the limit at half a mile. Only one man placed the limit at five miles. He had had an experience of thirty-six years, and was considered a man of excellent judgment. For myself, I have great respect for his judgment.

I now propose to show that this is not an idle inquiry. The number of steam and sailing vessels belonging to the United Kingdom of England, Ireland, and Scotland is about 25,000. The number belonging to the United States is at the present time about 22,000. These numbers vary from year to year with the conditions of trade and with the laws of supply and demand. A certain proportion are annually wrecked, either wholly or partially, the actual number for any given year varying to a certain extent with the total number of vessels, but being largely dependent upon the violence of the storms occurring during that year. But in a given series of years the average of the conditions of the latter class under which wrecks occur must be nearly the same, and the number of wrecks ought to be nearly proportional to the total number of vessels, under average conditions of carefulness in navigation. It is therefore essential to our investigation to inquire *whether the ratio of the number of wrecks to the total number of vessels in a given series of years is an increasing or a decreasing ratio.*

The following data are, for Great Britain, derived from the returns to the British Board of Trade, under the title of Wrecks and Casualties, and for the United States from the reports of the U. S. Life Saving Service. Inasmuch as the question of collisions does not necessarily come within the scope of the present investigation, the number of wrecks and casualties are given both including and excluding collisions.

GREAT BRITAIN.

Year.	No. Vessels (Steam and Sailing).	Total Tonnage.	No. of Wrecks including Collisions.	No. of Collisions.	No. of Wrecks excluding Collisions.
1856	25335	4304460	1153	316	837
1857	26219	4491377	1143	277	866
1858	26658	4587893	1170	301	869
1859	26804	4591250	1416	349	1067
1860	26764	4586742	1379	298	1081
1861	27142	4735491	1494	323	1171
1862	27525	4860191	1488	338	1150
1863	27750	5251757	1664	331	1333
1864	27737	5542878	1390	351	1039
1865	27868	5666873	1656	354	1302
1866	28072	5692010	1860	422	1438
1867	27918	5670350	2090	414	1676
1868	27635	5698774	1747	379	1368
1869	26389	5634727	2114	461	1653
1870	25643	5617693	1502	361	1141
1871	25188	5622660	1575	351	1224
1872	25093	5681963	1958	409	1549
1873	24873	5736368	1803	381	1422

UNITED STATES.

1873–4	.....	.....	1060	...	....
1874–5	.....	.....	1610	...	....
1875–6	22577	.....	2097	576	1521
1876–7	22476	.....	1935	521	1414
1877–8	21995	.....	1816	545	1271
1878–9	21611	.....	1953	568	1385

It is at once apparent from the returns for Great Britain that with a *decrease* in the number of vessels we have an *increase* in the number of wrecks and casualties. Comparing the data for the first half of the series with the data for the second half we have the following:

Limiting Dates.	Average No. of Vessels.	Average Tonnage.	Average No. of Wrecks including Collisions.	Average No. of Collisions.	Average No. of Wrecks excluding Collisions.
1856–64	26882	4772449	1366	320	1046
1865–73	26520	5669046	1813	393	1419

Decrease in the number of vessels, 1 per cent.
Increase in the total tonnage, 19 per cent.
Increase in the number of wrecks including collisions, 33 per cent.
Increase in the number of collisions, 23 per cent.
Increase in the number of wrecks excluding collisions, 36 per cent.

The percentage of decrease for the number of vessels should really be considerably greater than appears from the table, since previous to 1865 the enumeration was limited to vessels of eight tons, while after 1865 all vessels of three tons and upwards were placed upon the register.

In the returns for the United States, the numbers for 1873–4 and 1874–5 are undoubtedly too small, as no adequate means were employed for collecting the data till after the congressional act of 1874. For the four years for which we have reliable data, the average number of wrecks excluding collisions is 1398, which, in proportion to the number of vessels, is somewhat less than the number for Great Britain during the years 1865–73.

Comparing the number of collisions which occurred in Great Britain with the number which occurred in the United States we find:

In Great Britain the ratio to the number of vessels is as 1 to 67.

In the United States the ratio to the number of vessels is as 1 to 43.

Since in a large number of cases the average of all the causes, except carelessness, which produce collisions must be a constant, the modulus of carelessness as between Great Britain and the United States may be stated to be as nearly as 2 to 3 in favor of the United States.

These comparisons seem to justify a new discussion of the whole problem of wrecks and their causes. The arrangements for collecting data respecting wrecks, under the auspices of the British Board of Trade, have been constantly improved since their inauguration in 1855. In the United States the improvement in this respect since the organization of the Life Saving Service in 1871, and especially since the more complete organization in 1875, is signally marked. In both countries, especially in Great Britain, the rules for the examination of both inferior and superior officers are rigidly enforced. In no other countries are courts of inquiry upon disasters more surely held or more thoroughly conducted, and yet with all these precautions it is almost certain that the average number of wrecks in any given series of years will exceed those for the same number of preceding years, the number of vessels remaining the same. It is hardly probable that unknown or unsuspected elements enter into this problem. It is possible, however, that the limits of official investigation may be enlarged with great advantage.

I shall presently attempt to ascertain the ratio of wrecks which occur from preventable causes. If I were asked to name the one cause

which, next to positive negligence, produced the largest number of wrecks *of this class*, I should say, *over-confidence*. This excess of confidence is, in general, inversely proportional to the intelligence of the navigator. Of course, a successful sea-captain *must* rely upon his judgment; but the inevitable tendency of many years of service, with almost every possible form of experience, is to convince him that his judgment is rarely in error. Especially is this the case in too positive forecasts of the weather, in the accuracy of his observations for position at sea, and in the performance of his chronometer. Of course he places the utmost confidence in the accuracy of all data derived from the Nautical Almanac. I shall presently show that even here this confidence is not justified. In 1860, Professor Main, in his address before the Royal Astronomical Society, said, "Hansen's Tables (of the moon) are practically perfect for all the purposes of navigation, and the great nautical problem of finding the longitude at sea is now completely solved." Is it not possible that assertions like this inspire a confidence which may be the cause of more wrecks than has been hitherto supposed? Is it a fact that the problem is completely solved? I assert distinctly that it is not. I know of no more mischievous and misleading statement than this by Mr. Main, unless it be that of our own countryman, Lieut. Maury, on the performance of the chronometers used in the Grinnell Arctic Exploring Expedition. In a letter to the makers, he says, "The instruments have been subjected to the severest tests to which it is possible to subject instruments of such delicate construction, yet so exquisitely were they provided with adjustments and compensations for the very great extreme of temperature to which they were subjected, that one of them, No. 114, Loseby, after having suffered all sorts of exposure to which such instruments are liable in a polar winter, is returned with a change in its daily rate during seventeen months of only .03 s." (Signed) M. F. Maury.

This may be called a first-class recommendation, and this endorsement being good by inference for all of Mr. Loseby's chronometers, purchasers are led to suppose that they are as near perfection as human skill can make them. By reference to the report of the annual trial of chronometers at the Greenwich observatory it appears that while Loseby made some very excellent chronometers, he made also some very poor ones. I think I am safe in saying that this is the experience with the chronometers of every first-class maker.

Let us now see what is the actual state of the official inquiries into the causes of wrecks. By the Merchant's Shipping Act of 1854, it is assumed in the preliminary courts of inquiry, testimony which is held valid in Admiralty courts, that a vessel may be lost:

(*a*) By the act of God, *e. g.* being injured or destroyed by lightning, unavoidable perils of the sea, &c.

(*b*) By collision.

(*c*) By error of judgment, incompetency of master, or officers, or pilots.

(*d*) By bursting of boilers, breaking machinery, &c.

(*e*) By the removal of buoys, beacons, &c.

(*f*) By direct and wilful casting away.

(*g*) By inattention to necessary repairs.

(*h*) By defective charts.

(*i*) By not providing proper apparel and equipments for officers and crew.

(*j*) By improper loading or stowage.

(*k*) By neglect of regulations for preventing collisions.

(*l*) By employing a vessel in a trade for which she is unfit.

(*m*) By act of the Queen's enemies.

The nautical literature of this period is full of additional causes and remedies. The most important of these are:

(*n*) Failure to get the latitude.

(*o*) Failure to heave the lead.

(*p*) Unexpected deviation of compass.

One writer adds with a grain of truth, two other causes:

(*q*) A dead-and-alive set—no devil on board.

(*r*) Discord and dissension—the devil let loose.

An examination of the special and official inquiries into wrecks and casualties, and their causes, will show that the findings are based on one or more of these causes.

As an illustration, it appears from the Wreck Register for 1869 that there were during that year ninety-seven trials with the following results:

No. Cases	97
Acquittal from blame	39
Censures	10
Certificates cancelled, (drunkenness)	3
Certificate suspended, 5 years	1

Certificate suspended,	18	months.	. . .	2
" "	12	"	. . . .	12
" "	9	"	. . . .	2
" "	6	"	. . . .	16
" "	3	"	. . . .	4
" "	2	"	. . . .	2
Left for decision of higher court			. . .	6
			Total . .	97

It is my purpose in this investigation to examine only those cases of wrecks which in a measure seem to have escaped attention in official investigations. They are—

I. Wrecks which occur from preventable causes.

II. Wrecks resulting directly or indirectly from over-insurance.

III. Wrecks caused by the deviation of the compass.

IV. Wrecks caused by errors of observations at sea.

In attempting to distinguish between the causes of wrecks, one is compelled to acknowledge at the outset that the statistics reveal certain facts which in the present state of our knowledge are very difficult to explain. Apparently the most feasible way of ascertaining what proportion of wrecks occur from preventable causes, is to account for those which occur from all other causes which can be clearly assigned, and after making a proper allowance for unknown causes, to place the balance in this class. But this cannot be safely done till further investigations are made with respect to certain facts which are revealed by the statistics already accumulated. These may be stated as follows:

(a) *The number of wrecks involving total loss is nearly proportional to the total number of vessels, while the number of wrecks involving partial loss shows a steady increase from year to year.* This will appear from the following table.

WRECKS OTHER THAN COLLISIONS IN THE UNITED KINGDOM.

Year.	Total Loss.	Partial Loss.	Year.	Total Loss.	Partial Loss.
1856	368	469	1867	356	1020
1857	384	482	1868	527	841
1858	351	515	1869	606	1047
1859	527	540	1870	411	730
1860	476	605	1871	398	826
1861	513	658	1872	439	1110
1862	455	695	Jan. to June 1873	212	522
1863	503	830	June to June 1873–4	346	1076
1864	386	653			
1866	470	832			

(b) *The increase in the number of wrecks outside of the "At Home" limits is proportionately much larger than within those limits.* The "At Home" limits "embraces the cases which happen in waters within 10 miles from the shores of the United Kingdom; in waters within any bays or estuaries; in waters around any outlying sand-banks which are dry at low water; in the seas between Great Britain and Ireland; and between Orkney and Shetland and Western Islands and the mainland of Scotland." Returns of this class began with 1867. I extract from the returns for 1873–4 the following significant numbers for British vessels only.

	1867	1868	1869	1870	1871	1872	Jan. to June. 1873	June to June. 1873–4
Total No. of wrecks, casualties and collisions.	935	935	961	1208	1754	2415	1156	3094

These numbers include vessels belonging to the British possessions, but the total numbers belonging to this class follow nearly the same law as those which are referred to the United Kingdom; *i. e.*, there is a steady *increase* till about 1866, and after that a steady *decrease* till 1874.

(c) *Over one-half of the total number of wrecks occur when the wind blows less than a fresh gale, or "when a ship if properly found, manned and navigated can keep the sea with safety."* The following table furnishes conclusive evidence on this point. It is taken from the Wreck Register for 1875.

WRECKS CLASSIFIED ACCORDING TO THE FORCE OF THE WIND.

1864 –65	1865 –66	1866 –67	1867 –68	1868 –69	1869 –70	1870 –71	1871 –72	1872 –73	1873 –74	Total.	
23	19	12	15	16	25	33	31	26	29	229	Calm.
18	26	27	22	31	32	57	42	57	48	360	Light air.
92	95	65	61	93	115	115	109	136	129	1010	Light breeze.
23	19	31	35	25	37	50	52	65	68	405	Gentle breeze.
149	150	176	150	157	162	161	198	175	211	1689	Moderate breeze
210	228	228	199	185	208	180	213	248	234	2131	Fresh breeze.
175	187	230	196	250	205	234	255	312	283	2329	Strong breeze.
46	52	97	59	78	50	80	95	197	165	919	Moderate gale.
48	77	88	120	54	61	37	96	240	149	1020	Fresh gale.
414	605	617	417	629	515	536	234	348	205	4320	Strong gale.
211	157	204	310	139	186	182	136	246	160	1921	Whole gale.
37	46	28	62	29	34	29	21	56	31	373	Storm.
49	173	61	72	89	93	38	26	38	27	666	Hurricane.
9	2	1	2	—	—	5	8	8	22	57	Variable.
59	73	72	77	97	91	61	15	52	42	639	Unknown.

(d) *The number of wrecks is proportionately larger for new vessels than for those which have reached the average age of service.*

Data:

FOR GREAT BRITAIN.

Age, Limiting Years.	1865	1866	1867	1868	1869	1870	1871	1872	Jan. to June, 1873	1873–4	Total.
0– 3	151	277	209	176	198	130	155	211	94	182	1733
3– 7	260	280	322	297	406	307	302	374	209	354	3111
8–10	203	221	238	152	218	148	163	239	127	254	1963
11–14	173	198	262	268	308	218	198	242	136	227	2230
15–20	269	289	306	270	314	246	243	322	170	318	2747
21–30	352	419	441	383	436	272	311	344	163	297	3418
31–40	145	174	209	167	229	143	184	212	118	221	1802
41–50	84	87	118	100	112	63	81	86	61	81	873
51–60	51	53	60	35	53	49	[illegible]	47	19	41	452
61–70	20	25	36	28	18	20	[illegible]	24	13	13	216
71–80	9	13	9	9	9	4	[illegible]	17	8	6	90
81–90	5	5	3	8	5	5	8	4	2	5	50
91–100	1	2	1	..	2	..	..	5	..	2	13
101+	1	..	1	..	..	1	3	2	2	2	12
Unknown.	288	296	298	238	286	259	210	252	84	188	2399

FOR THE UNITED STATES.

Age, Limiting Years.	1875–76	1876–77	1877–78	1878–79	Total.
0– 3	341	246	159	128	874
3– 7	318	276	368	305	1267
7–10	357	227	278	287	1149
10–14	275	243	324	307	1149
14–20	243	173	197	262	875
20–25	160	113	164	161	598
25–30	103	83	99	112	397
30–35	17	20	32	44	113
35–40	26	21	20	18	85
40–45	8	12	8	14	42
45–50	4	3	6	3	16
50+	7	1	4	7	19
Unknown	164	107	153	94	518

(e) *The number of wrecks is to a large extent dependent on the character of the cargoes of the vessels wrecked.*

Data:

FOR GREAT BRITAIN.

	Ballast [not Colliers].	Coal.	Colliers in ballast.	Fishing Smacks.	Grain and Provisions.	General Mdse.	Lumber.	Stone and Bricks.	All others.	Total.
1864–65	191	550	131	101	119	78	88	105	550	1913
1865–66	244	701	119	109	178	77	115	136	657	2336
1866–67	234	713	179	117	158	82	94	153	640	2370
1867–68	229	617	165	173	120	82	84	137	563	2170
1868–69	252	693	130	140	117	103	72	161	668	2306
1869–70	247	559	160	124	145	114	116	164	597	2226
1870–71	202	541	96	91	139	77	89	125	644	2004
1871–72	218	524	104	126	105	88	52	101	572	1890
1872–73	278	788	109	100	244	116	168	166	732	2692
1873–74	256	539	67	165	131	110	161	175	587	2191
Means.....	235	623	125	126	146	93	98	143	621	2210

FOR THE UNITED STATES.

1875–76	474	273	...	148	114	125	178	57	654	2023
1876–77	426	248	...	74	61	129	224	28	697	1887
1877–78	413	244	...	64	117	102	200	38	643	1821
1878–79	474	273	...	88	103	125	466	23	521	2023
Means.....	447	259	...	81	99	120	267	36	629	1938

After making a liberal allowance for the larger number of vessels engaged in certain kinds of trade, it still remains that there is an excessive number of wrecks corresponding to certain classes of cargoes. I do not pretend to offer any explanation of the questions raised by a study of these tables. I can only call attention to the need of a careful study of the hidden causes of the anomalies which they reveal.

In attempting to ascertain the ratio of wrecks which occur from preventable causes, I am limited to two sources of information; these are:

(*a*) The numerical data furnished by the Wreck Register for Great Britain, and by the reports of the Life Saving Service for the United States.

(*b*) The comparison of the findings of the courts of inquiry upon the causes of wrecks, casualties and collisions, ordered by the British Board of Trade or reported to this Board. Both in Great Britain and in the United States an attempt is made to distinguish the causes of all the wrecks which occur. In the British Wreck Register these causes are grouped in four classes as follows:

CLASS I.

1. Foundering.
2. Driving or running on a sand or lee shore.
3. Parting cables.
4. Dragging anchors.
5. Damage to hull or rudder, or loss of masts, yards, sails, &c.
6. Shifting of cargo or ballast.
7. Missing stays.
8. Failing to make harbor, or stranding whilst entering.
9. Capsizing.

CLASS II.

1. Error, neglect or incompetency of master or mate.
2. Error, neglect or incompetency of pilots.
3. Improper stowage.
4. Not heaving lead.

CLASS III.

1. Unseaworthiness.
2. Overloading.
3. Defective charts, insufficient manning, unsound gear or equipments, imperfect repairs, or defective construction.
4. Local attraction and defects of compasses.

CLASS IV.

1. Thick and foggy weather.
2. Heavy seas.
3. Strong currents and light winds.
4. Want of lights or buoys on coasts and shoals.
5. Want of pilot.
6. Want of power in steam tugs, or defective tow ropes.
7. Striking on sunken wreck, &c.
8. Spontaneous combustion.
9. Fire or lightning.
10. Damage to boilers or machinery.
11. Accident.
12. Combination of causes.

In the reports of the Life Saving Service the causes are also grouped under four classes, but the arrangement is somewhat different from that given above.

In 1877, the two causes, "damage to machinery," and "explosion of boiler, bursting of steam pipes, etc.," were separated from Class IV and were grouped in a class by themselves. In this investigation the original grouping has been retained.

These classes are:

CLASS I.

1. Foundered.
2. Stranded.
3. Sprung a leak.
4. Capsized.
5. Waterlogged.
6. Damage to hull, rigging, rudder, &c.
7. Struck by lightning.
8. Machinery disabled.
9. Miscellaneous.

CLASS II.

1. Error in judgment.
2. Error of pilot.
3. Neglect of master.
4. Ignorance.
5. Carelessness.

CLASS III.

1. Defective instruments.
2. Defective hull, rigging, &c.

CLASS IV.

1. Adverse currents.
2. Heavy sea.
3. Accidental.
4. Fire.
5. Never heard from.
6. Thick and foggy weather.
7. Misstayed.
8. Sprung a leak.
9. Becalmed.
10. Parted chains, &c.
11. Struck bridges, piers, &c.
12. Waterlogged.
13. Explosion.
14. Absence of proper lights.
15. Miscellaneous.
16. Ice.
17. Machinery disabled.
18. High wind.
19. Darkness.
20. Tides.
21. Unknown.

Under the subdivisions given above we have the following data:

For Great Britain.

Wrecks and Casualties other than Collisions for 10 Years.

Year.	Wrecks resulting in Total Loss arising from					Casualties resulting in Partial Damage, arising from					Total.
	Class I.	Class II.	Class III.	Class IV.	Unknown.	Class I.	Class II.	Class III.	Class IV.	Unknown.	
1865–6	320	120	62	64	19	574	127	47	143	11	1487
1866–7	340	121	74	72	15	538	120	65	161	10	1516
1867–8	269	85	55	87	20	571	130	70	134	6	1427
1868–9	276	94	95	96	17	470	151	84	160	8	1451
1869–70	253	66	56	89	36	557	134	65	150	6	1412
1870–1	203	89	58	97	26	375	159	102	176	8	1293
1871–2	72	104	43	78	13	341	199	144	158	5	1157
1872–3	185	95	52	97	67	632	223	133	244	4	1732
1873–4	128	93	30	53	42	525	180	91	251	29	1422
1874–5*	177	84	33	75	42	393†	182	129	240	37	2931
						906‡	234	59	325	15	
Total for 10 Years	2223	1509		1105		5882	2828		2281		15828

* In this year the partial damage is subdivided into † serious and ‡ minor casualties.

For the United States.

Year.	Class I.	Class II.	Class III.	Class IV.
1865–6	804	82	35	524
1866–7	706	50	33	543
1867–8	940	20	55	261
1868–9	990	18	74	336
Means	860	42	49	416

From these figures it is impossible to draw other than very general conclusions. Since the causes enumerated in Class IV are about equally divided between those which may be classed as preventable and those which are non-preventable, we may with tolerable confidence compare Classes I and II.

It appears therefore that for the total number of wrecks excluding collisions, 45 per cent. are due to preventable causes.

For the United States I can offer no explanation of the extremely small ratio of Class II to Class I. The omission of the cause "failure to heave the lead," suggests that the data is not altogether reliable. That this cause cannot be safely omitted will appear from the fact that between 1856 and 1872, out of less than five hundred cases of punishment imposed for default by English courts of inquiry, 102 were for "neglect of lead."

In 1865 the British Board of Trade began the yearly publication of a resumé of the findings of the courts of inquiry instituted for ascertaining the causes of wrecks, and for the punishment of those convicted of default in navigation, by reprimand, by suspension or cancellation of certificates of competency, and even by fines and imprisonments. In the Wreck Register for 1873 there is a brief resumé of all the trials which occurred between 1856 and 1873. The total number is 1163. I have examined each of these findings, and selected those in which there is a clear acquittal from blame, care being taken to exclude all cases in which there is even an admonition, although the certificate was returned. From this examination it appears that there were 384 cases out of the total number 1163 in which the casualties occurred from causes clearly beyond the control of the master or mate.

From an examination of the findings between 1867 and 1874 I find the following results:

Year.	No. of Acquittals.	Total No. of trials.	Year.	No. of Acquittals.	Total No. of trials.
1865	29	46	1870	86	251
1866	46	81	1871	44	130
1867	9	30	1872	70	169
1868	21	47	1873	38	102
1869	39	97	1874	122	314

We have here 504 clear acquittals in 1267 trials, giving a ratio not far different from that obtained from the findings between 1856 and 1872, in which as nearly as can be made out the cases tried were different from those recorded in the annual volumes.

It is not to be understood that the findings in the remaining 763 trials are all for default of the master or mate, inasmuch as the inquiries often extended to their conduct *after* the casualties occurred.

In the Register for 1876 there is a remarkable increase of the number of trials reported, covering the years 1874–5 and 1875–6. I copy the summary given:

Cancellation of certificates	11
Suspension of certificates	204
Certificates returned	173
Unseaworthiness	13
Overloading, bad stowage	18
Defects in equipments	7
Stress of weather	128
Fire or other accidents	68
Cause not stated	64
Total	691

In both of these investigations there is one class of wrecks for which no cause can be safely assigned, viz. that involving vessels which were never heard from after sailing, for in these cases there are no records either of efforts made or of sufferings endured. The reports with respect to this class of wrecks are very defective. In the Wreck Register for 1874 there is for the first time a separate list of British ships not heard from after sailing. Of this class there were 83 in 1873–4, 137 in 1874–5, and 101 in 1875–6. The total number reported in the reports of the Life Saving Service for the years 1875–6 to 1878–9 is 59. It is probable that these numbers are somewhat too small, for according to the Insurance Reports of Great Britain there were between 1864 and 1869 (inclusive?) 10,588 wrecks of which the end of 846 is unknown.

There is also another class of wrecks which may be much larger than is usually supposed, viz. wrecks for which it is exceedingly difficult to determine the true cause. In any given investigation it is imperative that the inquiry shall be extended beyond the immediate cause. A wreck may apparently occur by the act of God and yet be due to the previous folly of man. Take the case of the barque Providence, which sprung a leak in the Baltic on a voyage to Dantzic. After the crew had arrived at the last point of exhaustion in their efforts to stop the leak, it suddenly stopped, and the vessel arrived safely at her destination. After the discharge of the cargo it was found that the leak had been caused by the giving way of a knot in a bottom plank, and that it had been stopped by a dead fish, which acted as a plug. If the vessel had been lost there would have been no evidence of the cause. As it turned out, the builder had to suffer the penalty for what might have been charged with apparent reason as an act of

God. One can hardly tell where to place the case of the steamship L'Amerique of the French line between New York and Havre. She sprang a leak, and after being abandoned, was picked up and manned by a British crew, when it was found that through the ignorance of the engineer the donkey engine had been pumping water *into* instead of out of the ship.

Combining the results obtained from these independent inquiries, the general conclusion is reached that about one-half of all the wrecks which occur may be due to preventable causes.

Under the second head a complete and satisfactory investigation is wellnigh impossible. That the whole question of insurance in connection with wrecks involves more or less of fraud is evident from the following extract of a speech before the United Service Institution by Admiral Halstead, Secretary of Lloyds. He said: "The remedy for shipwrecks—what is it? I do not pretend for one instant to be able to provide a remedy, and I do not know anybody who can undertake to say what is a remedy; but I will tell you this: if I could go on the Stock exchange to-morrow morning, and by holding up my hand put a stop to all shipwrecks upon the coast, it would be a question how I could get safe with life off that Exchange. When I put that question to him (Lloyd) he said, '*It is perfectly true, you would stop our bread.*'"

As for definite data, it is only possible from the nature of the case to obtain a little here and a little there. The cases of the Dryad and the Harlequin, in 1837, show that in those days at least the question of insurance had a very definite bearing upon the question of wrecks.

In 1866, Thomas Berwick was connected as an accessory in the destruction of ships owned by Thos. Berwick & Son. On his trial he confessed to having destroyed no less than nine vessels in the course of twenty years.

In 1867 there were in the Baltic 215 British vessels, and in 1868, 220 Swedish. The British vessels were largely insured, while on the Swedish vessels there was very little, if any insurance. Of these numbers, 17 British and 3 Swedish were lost. From 1857 to 1867 the ratio was 10 British to 3 Swedish. It is hardly probable that this disparity of numbers can be accounted for by the superior skill of the Swedish navigators.

The data which I shall now offer will need to be taken with a large allowance for imperfect returns, but the near approach of the total insurance to the total value of the vessels and cargoes lost, and espe-

cially the large excess of the insurance over the actual loss, proves either that the business of insurance involves enormous profits, or that it involves extensive fraud on the part of those who insure. As before, the returns are derived from the Wreck Register for 1875, and from the annual reports of the Life Saving Service between 1875–6 and 1878–9.

For Great Britain.

Vessels.

Year.	Total No. Insured.	Total Am't of Insurance	No. rp'd not Insur'd.	Unknown.	No. on which loss was report'd	Estimated loss.	Av'g am't of Ins. on each vessel.	Aver'ge loss on each vessel.
1865	811	£1,102,070	298	903	1331	£1,000,568	£1359	£797
1866	804	1,250,262	416	979	1854	1,018,000	1399	549
1867	1072	1,380,912	481	965	2987	1,282,888	1288	621
1868	905	1,195,025	456	779	1727	899,604	1317	522
1869	1114	1,758,356	478	1062	2102	1,240,535	1578	590
1870	711	1,474,414	356	708	1483	964,317	2074	650
1871	800	1,623,099	419	708	1565	1,141,845	2029	730
1872	1009	2,092,830	477	895	1950	1,165,466	2074	598
Jan–Jun 1873	500	1,205,743	227	479	1006	582,489	2531	579
1873–4	847	1,930,907	502	842	1842	809,201	2280	488
1874–5	1597	4,280,813	806	1769	3347	1,309,709	2681	409

Cargoes.

1865	108	£115,905	135	1312	468	£500,467	£1073	£1069
1866	160	376,869	167	1512	500	453,640	2355	709
1867	212	309,117	228	1413	637	625,602	1416	982
1868	183	290,985	202	1276	529	363,697	1639	688
1869	284	487,506	226	1498	642	345,843	1717	539
1870	182	482,348	213	1135	486	414,510	2650	853
1871	201	703,262	257	1086	475	372,772	3499	785
1872	282	473,448	363	1374	536	428,402	1680	799
Jan–Jun 1873	141	248,282	114	723	284	296,997	1761	1045
1873–4	270	324,806	226	1227	406	289,096	1200	712
1874–5	311	807,200	467	2380	495	334,054	2595	675

For the United States.

Vessels.

Year.	Total No.	Total Value.	Total No.	Total Loss.	Total No.	Total Am't Insured.	Average value of each vessel.	Avg loss on each vessel.	Average Ins. on each vessel.
1875–6	1800	$33,839,675	1788	$7,025,192	807	$11,677,106	$18,000	$3929	$14,470
1876–7	1771	35,973,839	1709	8,834,202	782	10,258,611	20,313	5169	13,118
1877–8	1724	29,195,845	1640	6,963,084	748	8,681,180	16,936	4246	11,606
1878–9	1853	29,450,062	1749	5,899,159	733	7,339,011	15,893	3373	10,012

Cargoes.

1875–6	1307	$17,333,633	586	$2,687,228	487	$ 8,589,516	$13,262	$4586	$17,638
1876–7	1283	21,230,636	612	4,548,958	598	11,882,253	16,548	7433	19,870
1877–8	1276	18,738,387	621	3,979,800	562	9,678,110	14,685	6409	17,221
1878–9	1343	16,890,305	630	4,284,836	563	7,751,431	12,577	6801	13,768

Under the third heading my investigations are far from complete or satisfactory, on account of the difficulty of obtaining reliable data. The compass problem is an intricate one, and has never been fully solved, though the researches of Flinders, Barlow, Scoresby, Airy, and Harkness have done much to convert great uncertainty into tolerable certainty. The discovery of the deviation of the compass is undoubtedly due to Columbus, though the claim is sometimes put forward in behalf of one Peter Adsiger, based on a manuscript deposited in the University of Leyden. But Humboldt has shown that this claim is a spurious one. The first observations on the variation were by Bond, in 1668. But the variation is a very irregular one. There are both yearly, monthly, and diurnal inequalities, the diurnal variation being discovered by Graham in 1722. (The dip of the needle is said to have been discovered by Robert Norman in 1576.) The following short table of variations at Greenwich will illustrate both their magnitude and their irregularity.

Year.	Mean variation Greenwich.	Range during year.
1865	20° 32′ 43″	3′
1866	20 27 47	11
1867	20 20 17	7
1868	20 13 14	6
1869	... ...	0

As an illustration of the monthly irregularity of variation, I give the Greenwich record for the first six months of 1841:

Month.	Variation.	Change from one month to next.
Jan.	23° 11′ 46″	+5′ 50″
Feb.	17 36	+1 42
Mar.	19 18	−7 30
April	11 48	+5 54
May	17 42	−1 24
June	16 18	

Here we have variations between different months amounting to nearly one-fourth of a degree. But the fluctuations of a single day are often more than for a whole month. These diurnal fluctuations are well illustrated by the following curve taken from the Greenwich observations of 1869.

The variation for long periods is well illustrated by comparing Halley's Chart for 1700 with modern charts. But the complexity of the problem does not stop here.

The tendency of the present time is to build iron ships, and all ships now have more or less iron in their construction. These ships become to a greater or less degree themselves great magnets. In wholly iron ships the uncorrected deviation of the needle often amounts to 50°, thus rendering it wholly useless. Captain Flinders in his voyage to Australia in 1811 was the first to make an intelligent discussion of this subject. The result of his investigations may be stated as follows:

I. A compass gives different bearings of the same object when placed in different parts of the ship.

II. When the ship's head is on the magnetic meridian there is no effect from local attraction, showing that the various masses of iron on board act in unison with the earth's magnetism.

III. When the ship's head is east or west the effect of local attraction is the greatest, and that at intermediate points the deviation varies as the sine of the angular distance between the magnetic meridian and the bearing of the ship's head.

IV. The maximum variation is different in different parts of the world, varying as the distance from the magnetic equator.

The polar expeditions of 1818 fully confirmed Flinders' experiments. Before reaching Greenland the compass of the Alexandria differed from that of the Isabella 11°, and the same compasses gave results differing 11° when placed in different parts of the ship. As the vessels passed up Davis straits all the compasses became sluggish. In Sir Edward Parry's passage through Barrow strait his compasses became totally useless. The admiralty law in regard to swinging for the variation of the compass is a very clear statement of the case. It reads as follows:

"As the deviation or error of the compass caused by local attraction of the ship becomes changed in amount by any change in the ship's geographical position, and may be entirely reversed in its direction by the ship's proceeding from the northern to the southern hemisphere, it is to be invariably tested by azimuth and amplitude observations at sea, and the ship is to be swung for ascertaining the change of error on arrival at a foreign station, and also once each year, and the same is to be inserted in the log-book and sent to the Admiralty with the quarterly return for December."

The next important discovery in this connection was by Barlow, who found that all the influence of iron bodies exerted on the compass resides on the surface. This discovery paved the way for Airy's method of correcting compasses, which is by swinging the ship in

the usual way, and then correcting the local attraction of the ship by means of permanent magnets of soft iron conveniently placed with respect to the compass. But the most important discovery was made by Dr. Scoresby. He found that every iron ship is itself a magnet, and that it gets its magnetism while building by the inductive magnetism of the earth, the poles of the ship's magnetism depending on the position of the building-yard and the direction of the keel in construction. Dr. Scoresby made the voyage of the world in the Royal Charter to test his theory, found by induction, and found it fully confirmed. Before starting his compasses were corrected by Airy's plan. On arriving at Melbourne it was found that a complete inversion of the ship's magnetic polarity had taken place. Every stanchion, every standard, every davit, every mass of iron about the deck had in its upper surfaces acquired a northern instead of a southern polarity, and the starboard compass had lost nearly one-half of its original errors. On returning to the place of starting in the northern hemisphere, and swinging the ship, it was found that a re-inversion had taken place; but the compasses did not quite return to their original deviations, but retained a fraction of their errors. It has since been found that these changes are much greater in steam than in sailing vessels, as shown by observations on board the Vulcan (steam) and the Pandora (sailing).

In 1852–3 Dr. Scoresby, in a paper before the British Association, showed that there is a sensible difference in the deviation before and after steam is up. It is said that the compasses of a steam vessel when light and running before the wind with a high sea are practically useless.

Within a few years the effect of the heel of a ship on the deviation of the compass has been pretty fully investigated. In general it is found that when a ship's head is nearly E or W there is no sensible effect from heeling, that when it is N or S the effect is greatest, and that the marked end of the needle is attracted to the raised side of the ship in north latitudes, and *vice versa* in south latitudes. In iron ships 1° of heel produces from 1° to 2° variation of the compass, generally about 1°. In a voyage of the City of Sydney, iron, 1100 tons, the deviation amounted to 1½° for every degree of heel. This deviation may be almost wholly prevented by the use of elevated compasses.

More recent experience has shown that the magnetism of an iron ship does not attain its normal condition till some twelve months

after launching, and that for some time after the variation is very irregular. In the Great Eastern, a fixed compass changed its deviation nearly three points in the first nine months of service. The observations of Professor Harkness on board a monitor seem to be conclusive on this point. It is apparent from this brief review that even with the utmost caution, ships may be misled by unknown variations, and yet the London Compass Committee as late as 1869 declare that very few ships are lost from this cause. What shall be said of ships that are never swung and whose masters know nothing of the laws of variation? The loss of the City of Washington is the best refutation of this statement. One of the most intelligent captains I ever met, a man who has commanded vessels for thirty-six years, and who has been to almost every great port on the surface of the globe, told me he had never swung his ship and that he had never seen a ship swung.

The opinion of the London committee was probably founded on the small number of disasters arising from errors of the compass reported in the annual returns. Between 1865 and 1874–5 only 34 cases are set down as due to this cause, while in the findings of the courts of inquiry between 1856 and 1872 there are only 21 cases of this class. In the U. S. Reports there are recorded 20 cases between 1875–6 and 1878–9, but here the distinction is not always made between "error of compass" and "error of chronometer."

That other competent authorities hold to a view radically different from that expressed by the London committee will appear from the correspondence between the Royal Society and the Board of Trade, printed in the Shipping Returns for 1865 (vol. LXV, 1866). The correspondence opens with the following letter:

ROYAL SOCIETY TO THE PRESIDENT OF THE BOARD OF TRADE.

THE ROYAL SOCIETY, BURLINGTON HOUSE, 25 May, 1865.

Sir:—The attention of the Fellows of the Royal Society has been recently directed to the very great increase which has taken place in the employment of iron in the construction and equipment of ships, and the consequent augmentation of the embarrassments occasioned in their navigation by the action of the ship's magnetism on their compasses.

The inconveniences which have already made themselves felt in the ships of the mercantile marine, and which threaten to be productive of very serious loss of life and property, unless remedial measures be adopted similar to those which have proved so advantageous to the ships of Her Majesty's navy, have induced the President and Council of the Royal Society, after much consideration, to

venture on the step of calling your attention, as presiding over the Department of Trade, to a subject which they believe to be of pressing importance.

In this view, the accompanying memorandum has been prepared, stating, as briefly as may be, the particulars which they are desirous of bringing under your consideration, in the belief that the time has fully arrived when measures of a more stringent and effectual character are required in the direction which has been already taken by Her Majesty's government in such legislative enactments as those contained in the "Merchant Shipping Act, 1854," adverted to in the accompanying memorandum.

I have only to add, that it would afford the President and Council great satisfaction if they could be of any further assistance in a matter which they believe to be of so much importance.

I have, &c.,

(Signed) EDWARD SABINE,
President of the Royal Society.

In the memorandum referred to, attention is called—

1. To the great increase in the number of iron ships, as well as in the amount of iron used in the construction of such ships.

2. To the losses of iron ships.

3. To the advances which have been made in, and the present state of the science of the deviation of the compass.

Also, the attention of the Board of Trade is drawn to the proposition to secure under competent authority—

(*a*) The correction of the compass in particular ships.

(*b*) The advancement of the science of the deviation of the compass.

(*c*) The education of masters and mates.

The reply of the Board of Trade to this communication contains a large amount of useful information, but fails, it seems to me, to grasp the vital point at issue, viz. the application to the mercantile marine of the system which has proved eminently satisfactory in the Royal navy.

The correspondence on the part of the Royal Society closes with the following communication:

THE ROYAL SOCIETY TO BOARD OF TRADE.

BURLINGTON HOUSE, 2d November, 1865.

Sir:—I have now laid before the Council of the Royal Society, your letter of the 25th of July, referring to the adjustment of the compasses of iron ships, and a copy of my letter of the 28th of August, acknowledging its receipt and adverting to the inquiry you had made as to the preparation of a "manual" on the

subject, together with your subsequent letter of 23d October having reference to the same inquiry.

The President and Council are much disappointed by learning that the Board of Trade are not prepared to give effect to the recommendation that the system which has been found to work so successfully in the Royal navy, of combining official and competent superintendence with a proper code of instruction, should be extended to the mercantile marine. They consider such superintendence to be essential, not only to the general introduction of a good and efficient mode of compass correction into the mercantile marine, but even to the discharge of the duties having respect to the adjustment of the compasses of sea-going passenger steamers, with which the Board of Trade is already charged by the legislature.

In the memorandum accompanying my letter of the 25th of May it was stated that many recent losses of iron steamers have taken place, in which it is probable that compass errors have occasioned the loss. The President and Council think it right to call the attention of the Board of Trade to the serious responsibility they incur in cases of loss of life and property arising from the want of a proper system of compass adjustment, by declining to take the course which is pointed out by the concurrent opinion of all competent advisers, as not only the best, but the only method of securing the introduction of such a system. They cannot but look forward to a time when the necessity of a proper supervision will be forced on the executive by public feeling, excited by some disastrous loss of human life traceable to the want of such superintendence.

The question is one of such vital importance that they desire to submit to the consideration of the Board of Trade the accompanying memorandum, replying in some detail to passages in your letter of 25th July.

I have, &c.,

(Signed) EDWARD SABINE,
President of the Royal Society.

As far as I can learn the compass problem still remains in the unsatisfactory state indicated by this correspondence.

[*To be continued.*]

NAVAL INSTITUTE—NEW YORK BRANCH.

JUNE 10, 1881.

LIEUT. F. HANFORD, U. S. N., in the Chair.

MAGAZINE SMALL ARMS.

BY LIEUT. W. W. KIMBALL, U. S. N.

Magazine small arms are those shoulder pieces and pistols whose systems of construction enable them to fire several successive rounds without reloading. They are divided into two general classes, *revolvers* and *repeaters*, the former firing their charges from several chambers from which, till the successive discharges take place, the cartridges are not moved; the latter firing from a single chamber into which, by the mechanism of the piece, the several cartridges are successively loaded, from an attached magazine.

It might be supposed that the desirability of firing several charges without reloading would have presented itself to the users of fire-arms at an early date; and, as a matter of fact, we find that an arm possessing this feature was produced in the century following that in which Friar Schwartz's famous mortar-pestle took its unexpected flight into the air at Mayence. A specimen of these 15th century shoulder piece revolvers is now in the armory of the Tower of London. It consists of a cylindrical breech piece revolving upon an arbor welded to the barrel and parallel with its axis; the whole fitted to a stock and held in place by a traverse pin; notches in a flange at the fore end of the cylinder receive the end of a spring fixed to the stock and extending across the breech, the function of the spring being to lock the cylinder when a chamber is brought up on line with the barrel. Each chamber is provided with a priming pan having a swing cover which, before firing, requires to be pushed aside by the

finger in order to present the priming powder to the lighted match. Repetition of fire is effected by throwing back the match holder and turning the breech by hand to bring up another loaded chamber. The fittings and mountings of this gun, very similar to which are two eight chambered revolvers in the Musée d'Artillerie at Paris, indicate an early Eastern origin.

Another match-lock magazine arm, brought from India by Lord William Bentinck, closely resembles in principle the one just described, but the workmanship is superior and the ornamentation ornate. The breech cylinder has five chambers, each with priming pan and swing cover. The arbor is attached to the barrel, and at the breech where it abuts on the cylinder the barrel is enlarged to correspond with the diameter of the cylinder, to which it forms a kind of shield. The thinness of the metal of the barrels and the extreme length of the chambers in all these specimens would indicate that they were used in the days of powder dust, before the comprehension of the utility of granulation.

The 16th century has its magazine gun representative in the Tower of London armory, in the shape of a pyrites wheel-lock, shoulder piece revolver. It has one priming pan common to all the six chambers of the cylinder; the pan is fitted with a sliding cover, and is so arranged that the serrated edge of the vertical wheel may project into it, and consequently into the priming powder; to this wheel a rapid motion is given by means of a trigger spring acting upon a link lever attached to the arbor of the wheel, the teeth of which striking upon the pyrites create the sparks that ignite the priming; the fire is then communicated laterally to a train of powder about 2.5″ long, before it reaches the charge in the cylinder. A repetition of fire is produced by rotating the cylinder by hand, repriming the pan and train channel, and setting in motion the wheel-lock, provided any sparks are generated; the probabilities that they would be seem to have been considered about equal to an even chance, with a small percentage in favor of failure, which accounts for the fact that a lighted match was held to be essential in wheel-lock gun shooting.

This gun has no tip stock, and the barrel is cut away on each side to allow the escape of the balls in case of premature explosions in the cylinder. There is a pistol of the same principle of construction at Woolwich. Both these arms show by their barrels that they were corned powder using weapons. A wheel-lock shoulder-piece eight chambered revolver of the 17th century in the Hotel Cluny at Paris

is in system similar to the one last described, but differs from it materially in the arrangement of the vents. There is a single priming channel from the pan to the rear of the cylinder, with eight corresponding tubes extending from the rear to within about a calibre of the front end, where a vent is pierced into each chamber. This arrangement was probably to prevent simultaneous explosion of the charges, and not an attempt to produce a better effect from the charge by igniting it directly in rear of the projectile. As in the 16th century gun, the priming channel and pan had to be refilled every time a chamber was discharged.

An elaborately finished Spanish gun, in the Cluny, probably of the early part of the last century, seems to come next in the chronological order of revolvers. This gun is a flint-lock; the cylinder is rotated by hand and is locked in the firing position, with a chamber in line with the barrel, by a pin which enters a hole in the rear end and which has to be withdrawn before bringing up a fresh chamber. The chief peculiarity of this gun is a magazine of priming powder immediately above a fixed pan, which serves for the four chambers of the breech; this magazine is hinged to the pan, and is fitted with a sliding bottom, which, when drawn out, is intended to allow a certain amount of the priming to fall into the pan, and when pushed back, to cut off the supply. The rear surface of this magazine serves also as a steel or striking surface for the flint, and is ribbed on its face. The gun has a tip stock covering the forward, and a cap enclosing the rear end of the cylinder; in using it it would seem that the priming powder in the magazine would inevitably explode; the priming fire would find its way to the other vents, and the lateral fire at the fore end of the cylinder would be directed into the other chambers and explode all the charges prematurely. In the armory of Warwick Castle there is a gun of about the same period that appears to be an attempt to insure greater safety in firing, at the expense of greater complexity of mechanism. It has a flint-lock and a hand-rotated four chambered cylinder. Each chamber is furnished with a priming pan and steel, which latter forms also the cover; therefore the firing of one charge is not so likely to ignite the powder in the other chambers. The tip stock is very light, so as not to cover the chambers; thus if a premature explosion took place, while there would be no material injury to the gun, the rest arm of the firer would probably be carried away. The cylinder seems to have been secured by a spring from the rear end of the barrel. An arm very similar in system to

the above is in the Tower armory, the breech system being composed of four distinct chamber tubes fastened together by two end plates and rotated by hand.

The next attempt at a magazine gun is shown in the Dafte gun, invented in England about the middle of the last century. There is evidently an endeavor, in this arm, to produce a more compact weapon, for instead of having a projecting pan and steel for each chamber, recesses are made in the periphery of the cylinder to form pans, and one steel was probably provided to stand over the breech and attached to the barrel. The cylinder containing six chambers is rotated by hand, and is locked when in firing position by a device like that in the pyrites wheel-lock gun. It would seem, from the holder of the steel being fastened over one of the chambers into which the fire would be deflected, that premature explosion would necessarily take place, that the steel would be broken off, and the gun rendered as useless as the man who fired it, at the first discharge.

In 1818, Elisha H. Collier, of Boston, Mass., patented a flint-lock shoulder-piece revolver. It had a priming magazine, a flue or channel that would conduct the fire to the different vents, a cap or shield in front of the cylinder which would direct lateral flame into the loaded chamber,—in short, all of the accessories that seem to have been so efficient in producing premature explosions. The cylinder was borne up against the barrel by a spring, and each chamber was counterbored at the forward end to receive the end of the barrel. This bearing up of the cylinder is maintained during the firing by a bolt which is thrust forward, when the trigger is pulled, by the action of a cam on the spindle of the hammer. Another flint-lock revolver was invented by a Mr. Wheeler, of Boston, in 1819. Its peculiar feature consists in a coiled spring made fast to the cylinder and to the arbor, which, being wound up, is intended to rotate the chambers automatically, an escapement device being operated by the action of the lock. In a marked degree it possesses all the properties that are so well calculated to discharge all the chambers at once.

In 1829, a New England boy, fifteen years of age, who had run away to sea from Amherst, Mass., where he had been at school, was shooting at porpoises off the Cape of Good Hope; being annoyed because he could have only a single shot before reloading his piece, he conceived the idea of a gun with several barrels, to be fired one after the other, and then concluded that revolving chambers with a single barrel would better answer his purpose. This conception he

proceeded to work out in wood, and the result so took his fancy that upon his return to the United States from Calcutta, whither his run away trip had landed him, he earned a little money at lecturing, and with it put his idea into metal. Half a dozen years later this invention was patented in England, and soon after in France and the United States: the problem of producing a practical magazine arm had been solved. In the first specification of the English patent granted to Samuel Colt, he claimed among other things, "the object of my principles, adaptations, and applications being to cause the said cylinder to revolve the distance from centre to centre of two contiguous chambers by the action of cocking the gun or pistol, and by the same action to lock the cylinder firmly in its place when so brought, and thus that no care or attention on the part of the person using the fire-arm is required in order to bring the charges into the proper place for being discharged through the barrel"; and that the arm was practical in "sixthly, in effectually separating the recesses (of the cylinder) in which the percussion tubes are placed from each other, so as to prevent fire communicating from the exploding cap to the adjoining ones."

The percussion cap had been invented, a Yankee boy applies it to the old revolving system, compels the action of the lock to rotate and lock the cylinder, and the problem that for four centuries had been vexing the gunmakers is solved—a practical magazine arm was produced. The Florida war, which followed so soon after the production of the Colt's revolver, gave the opportunity to prove its value in the field; an opportunity that was fully taken advantage of, in showing what such an arm could accomplish in the hands of men like Harney's rangers.

From that time the utility of the revolver became a fixed fact, and to-day, in 1880, it is the favorite side-arm ashore and afloat in all the countries of the world. As a shoulder piece it has never been extensively used; for, in the days of loose ammunition, the time taken to load the chambers militated against its efficiency for what was then considered long range fighting; and from its construction, the charges in the magazine—the cylinder—could not be readily held in reserve. Although numbers of Colt's revolving rifles were used in the Florida and Mexican wars, by plainsmen on the frontier, and even in the war of the Rebellion by Berdan's sharpshooters and by the infantry and cavalry under Fremont, in the shape of carbines and muskets, the place of the revolving principle as applied to military arms is and

was held to be upon the pistol; its duty to supply a rapid and successive fire at pistol practice range, a duty it has always performed satisfactorily, from the time that Fighting Jack Hayes of the Texas rangers attributed his successes to its aid, to the present time.

The history of the adaptation of the revolver to metallic ammunition is not a little curious, as an example of the way in which improvements in arms "grow" from what are apparently worthless devices. On the 3d of April, 1855, one of Colt's workmen, named White, patented a pistol, the principal feature of which was the boring of the chambers entirely through the cylinder in order to load from the rear; a leather gas check was used to stop the escape of the gas to the rear and laterally, a device entirely inefficient, as were most of those for accomplishing the same purpose when loose ammunition was used. This boring-through-the-cylinder arrangement was declined by Col. Colt, when offered to him, on the ground that it was worthless and had been patented in France twenty years before; and it was then acquired by Smith and Wesson, who, in 1858, when the Colt patents had run out, and when with improvements in metallic ammunition the breech-loading idea came to the fore, produced a breech-loading revolver, and for a time debarred other makers from boring through their cylinders to take the new cartridges; thus did the White device, originally considered worthless, become of great value to its possessors.

Within the two decades last past a great many changes and some improvements have been applied to the revolving type of magazine arms; but in general principle all the numerous revolvers of the present day are but so many modifications of the Colt's.

It would seem that the difficulty of disposing of the magazine in the repeating type of fire-arms, when that type is applied to pistols, has caused the retention of the revolver as a side-arm since the repeater has been so perfected for shoulder-piece work; for the breech of the pistol, from its size and shape, does not admit of the reception of a good magazine, while the placing of one longitudinally under the barrel is objectionable on account of the change of balance in the pistol hand as the charges are fired. Until a compact magazine, located at the breech of the barrel and having equality of but slightly changing the position of its centre of gravity as the charges are exhausted, shall be produced,* we may expect to see the revolver retain-

* The production of such a pistol would furnish a side-arm as well balanced and convenient as the revolver, while it would eliminate one of the principal objections to the revolving type of arms, *i. e.* the firing across a joint; an objection that is noticeable in all the revolver pistols of the present day, and that becomes a serious defect when the

ing its position as the favorite side-arm. At the present stage of pistol-making it is difficult to comprehend how any repeater could excel the many excellences of the tried and trusted revolver.

Repeaters.

It is evident, from the definition at the beginning of this article, that a *repeater*, in the narrower sense, must be a breech-loader; and it is a well established fact that the breech-loading of small arms was not successful before the appearance of metallic ammunition. If these two statements be correct, we should not expect to find practical repeaters among the earlier fire-arms. Although there may be many such, I have been unable to hear of any records or specimens of match-lock or wheel-lock guns containing the germs of the repeating idea. This idea seems to have had four distinct steps of development: 1. Firing in succession charges superimposed upon each other; 2. Loading loose powder and ball charges into a breech-block and successively firing them from it, across a seam between it and the barrel; 3. Loading paper cartridges into the chamber and firing them in succession; 4. Using self-primed metallic ammunition and eliminating the operation of priming.

Porta, in his *Natural Magick*, 1658, speaks of a great brass gun or hand gun which may discharge ten or more bullets without intermission. The idea was to load with powder and ball alternately until the barrel was full. An intervening "dark powder" gave an interval between the firing of the separate charges so as to avoid the simultaneous explosion of them all. Whether this "dark powder," which may have been some kind of sand wadding, accomplished its purpose or not, Porta does not say, and there seems to be no good reason for supposing it did; but still it is supposed to have been a gun of this type to which Pepys alluded in his Diary, 1662, when he wrote, "After dinner, was brought to Sir W. Compton a gun to discharge seven times, the best of all devices that ever I saw, and very serviceable and not a bauble; for it is much approved of and many thereof made."

system is applied to shoulder pieces. Any one can, at the expense of a coat sleeve prove to his own satisfaction that the escape of gas from the joint between the barrel and cylinder of a very accurately made arm is quite appreciable, by firing his belt pistol from the position of "Left arm rest, aim!" allowing, while doing so, the barrel of the revolver to lie on the arm above the elbow and the face of the cylinder to drop inside and below.

There is the possession of the Winchester Repeating Arms Co. a flint-lock musket, invented by an American named North, in 1825, that was intended to fire several successive charges without using revolving chambers. This gun differs from an ordinary muzzle loading flint-lock musket, only in being provided with half a dozen vents with a lock-catch for each, and in having the lock, movable in a groove along the vented portion of the barrel, carry with it a magazine of priming powder. The gun was to be loaded with ordinary paper cartridges, one over the other till there was a powder charge abreast each vent; the distance between the vents being equal to the length of a cartridge. The lock was then to be pushed up to the forward vent and secured there by its catch in such a manner that the hole in the priming pan corresponded with it, and the first charge fired; the lock was then released, drawn back to the second vent, the priming magazine, by a cut-off arrangement, used to refill the pan, and the second charge fired, and so on till all the cartridges were used.

There is no evidence to show that the beautiful faith of the inventor was ever justified by the works of the gun; and assuredly in these degenerate days no one who knows anything of fire-arms would willingly fire the first charge from a fully loaded North gun—unless indeed by means of a very long string leading from the trigger through a very small hole in the wall of a good substantial bombproof. The fact that the specimen alluded to exists, with its barrel intact, strongly indicates that as a magazine gun it was never fired at all.

Another gun on the superimposed charge principle appeared in France in the first years of the use of the percussion lock. This gun, invented by M. Robert of Rheims, and afterward improved by MM. Gordon Aubry and Robert, had a series of locks and nipples enclosed in the stock under the barrel, each lock being shut off from the adjoining ones by a diaphragm, and all of them let off in turn by a pinion, which by an ingenious arrangement of a coiled spring and rack was for this purpose made to travel, by pressure on the trigger, along the inside of the stock. The distance between the nipples was equal to the length of a cartridge, as was the distance between the vents in the North gun. MM. Gordon Aubry and Robert were very particular in their direction for loading, and had marks on the rammer to show when the charges were properly home; like North they seemed to have had perfect faith that the charge next in rear of the one fired would prove an efficient gas check; though why they should it is

impossible to understand. Their claim for the gun is for "la facilité de faire partir plusieurs coups avec un seul canon et en superposant les charges."

But before the advent of metallic ammunition there were many attempts at producing magazine arms, attempts that would have been successful had the guns proved practical breech-loaders—the magazine part was not difficult—the fermature of the breech was the obstacle. It is possible that many arms of the type may have appeared earlier, but the first true repeater of which I have any knowledge is a flint-lock, loose-ammunition-using gun of the second decade of the present century, the invention of M. Henry, Ingénieur-Mécanicien à Paris. This gun had a powder magazine on the left side and a ball magazine on top of the barrel. By the action of the lever of the breech block a powder charge was taken from the side, a ball from the top, and at the same time the pan was primed. In speaking of the advantages of his gun M. Henry says:

"Ce fusil présente l'avantage d'être aussi vite chargé pour quatorze ou quinze coups qu'un fusil ordinaire pour un coup; par conséquent, il est plus prompt à répéter son feu, d'autant qu'on n'a qu'à faire mouvoir un levier qui fait tourner dans un tonnerre en fer, deux noix en acier, dont l'une laisse le passage à la poudre sortant d'un tube elliptique qui se prolonge le long du canon pour arriver au tonnerre par la grosse noix qui, de son côté, prend la balle d'un tube contigu qui la contient et l'amène de force sur la poudre; le levier étant ramené à son point de départ, procure ainsi la quantité de poudre nécessaire pour l' amorce du bassinet; ensuite on n'a qu'à armer et à faire feu; par conséquent, on peut tirer quatorze et quinze coups sans recharger. Ce fusil n'a point besoin de bagnette, ce qui gêne beaucoup dans l'exercise d'un combat; il a la propriété de porter plus loin qu'un fusil ordinaire, la balle sortant forcée; il possède, en outre, le précieux avantage de n'être pas sujet à crever, comme il arrive souvent, parce qu'il ne peut se charger par double ou triple charge," etc., etc.

This last "precious advantage" so plain to M. Henry early in the present century, was not very apparent to the ordnance authorities of the United States, till the twenty-five thousand muzzle-loaders recovered from the field of Gettysburg, nearly all with two, four, six and even twenty rounds in their barrels, demonstrated only too clearly that it was indeed an advantage too precious to be longer neglected.

From 1820 to 1860, the loose ammunition repeater appeared in various forms in this country and in Europe, always ingenious in

construction, usually too complex in its mechanism, and invariably failing for lack of a breech fermature, if for no other reason; the idea of the arm was, however, so attractive that a system of its type was patented in the United States as late as 1860, after metallic ammunition had been in general use for some years. This system, patented by Paul Boynton, Jan. 3, 1860, was intended for a pistol, and consisted of separate longitudinal powder and ball magazines under the barrel, together with a circular one on the breech containing percussion primers. By revolving the barrel and magazines about a central arbor a motion was obtained which by an ingenious device was made to take a ball from the ball magazine, a powder charge from the powder magazine, bring them both into the breech-block in rear of the barrel and drop a primer into the vent cup; the hammer was fitted with a piercer, like that of the ordinary metallic ammunition revolver, instead of with the cupped recess that was used with percussion cap locks. Another system looking to the same result was patented by J. D. Moore in March of the same year.

Of repeaters adapted to the use of the paper cartridge and percussion cap there are numerous records, showing that the magazines were applied, longitudinally under the barrel to feed the charges backward, obliquely in the breech stock to feed forward, above, below, at the side and around the breech, in short in all the ways in which magazines are applied to modern repeaters. Noticeable among arms of this type are the ingenious guns of M. Cass, patented in this country in 1848, and of J. Swyney, also patented in the United States in 1855. The first of these guns had a magazine in the stock consisting of a series of cartridge cells fastened upon an endless belt, which was perforated under the seat of each cell to allow the passage of a rammer that pushed the cartridge from its cell into the chamber, when this last was by the movement of the belt brought into the proper position; the action of a jointed lever under the breech moved the belt the required distance to bring the cartridges into the loading position, and then operated the rammer that successively loaded them into the chamber; a revolving disk, carrying as many nipples as there were charges in the magazine, and operated by the hammer in cocking, brought up a fresh percussion cap for each fire. The Swyney gun had a longitudinal charge magazine under the barrel, along which the charges were moved by a spiral spring as in the modern guns having magazines of that type, and a cap magazine in the stock. The action of a guard lever moved the breech block down to receive a

cartridge from the magazine, carried it up to the firing position, and at the same time capped the nipple on the block. Thus it appears that the magazine part of the repeater was an accomplished fact, while satisfactory breech loading was still an unsolved problem; unsolved, although by many excellent breech-loading devices, and notably by the old Sharp's system, it was very near solution.

Before attempting to trace the progress of the repeater through its post-percussion-cap course, it is first necessary to glance, in a cursory way, at the antecedents of that common parent of modern breech-loading magazine and machine arms, the self-primed metallic shell cartridge.

In 1812, Pauly, a French artillery officer, patronized and encouraged by Napoleon I, always anxious for the advent of the breech-loader, patented a breech-loading arm "et des cartouches de composition particulière." In a report made to the Société d'Encouragement pour l'Industrie Nationale, in July, 1814, Brillat de Savarin says of Pauly's cartridge, "La charge est renfermée dans une cartouche montée sur un culot de cuivre percé dans son centre et creusé de manière à recevoir une amorce de composition muriatique, sur laquelle vient frapper un barreau de fer mu par le grand ressort; la poudre frapper détonne, l'entincelle qui en résulte enflamme la poudre et le coup part avec un extrême rapidité." Paulin Desormeaux in speaking of these cartridges says: "Ces cartouches nouvelles portent avec elles une rosette d'amorce *ou double culasse mobile* qui sert de dépôt au résidu de la poudre, et, cette rosette étant renouvelée à chaque chargement, les armes sont aussi propres après un long service qu' auparavant." A cut of the gun with the charge in place shows that the cartridge was a paper envelope one, the rear of which was enclosed in centre primed copper shell; the gun was of the concealed lock firing-pin type. The advantage of centre priming was appreciated, and the fact that the shell was spoken of as "a movable double breech," would seem to show that its effect as a gas check was known; but be this as it may, a couple of years after de Savarin's report the gun was improved backward to use a detached primer, and eventually to the use of a flint lock, although the breech mechanism so far in advance of its contemporaries was retained for many years.

In 1836, Mons. Robert, of Paris, produced a copper shell cartridge made in two parts, a cylinder, and a cup that formed the flanged head which was filled with fulminate; and shortly after the Flobert cartridge appeared; this last had a drawn copper case and a thick head

which was filled with fulminate also. It would seem that both these cartridges provided good gas checks, but they were used only for fulminate cartridges in small calibre weapons, and the principle was not applied to long range or military guns.

In 1846, M. Houiller, of Paris, invented rim, centre, and pin fire cartridges with metallic shells. In the same year, Lefancheux, another Parisian gunmaker, improving upon a multi-barrel cap-lock pistol of the "pepper box" type, bored his cylinders entirely through, loaded them at the breech, and used pin-fire cartridges with copper gas checks, card-board bodies and metallic anvil primers. Lefancheux made a long step in advance; indeed he had all the requisites for a metallic cartridge with the exception of the flanged head. In 1854, Smith and Wesson produced a flanged head metallic cartridge which was also centre fire, but deficient in having no anvil, the fulminate being placed between the head of the shell and an indurated or hard metal disk forced in as far as the flange, and forming both a diaphragm to separate the fulminate and powder, and a resistance to the blow of the hammer. In 1856 the same manufacturers patented a loaded bullet, the powder being contained in a hollowed out recess, and held in place by a steel disk which was the bottom of a copper or brass case pressed into the cavity in the bullet; this case contained the fulminate upon the steel disk, which in turn was covered by a disk of cork. A firing-pin entering through a hole in the top of the brass case was pressed through the cork and brought in contact with the fulminate. A blow on the firing-pin by the hammer was then expected to detonate the fulminate and so explode the powder. Sometimes it did.

In 1856 the Maynard cartridge appeared. This was a metallic shell, centre fire, unprimed cartridge carrying a double canalured ogival pointed bullet, with the lubricant in the canalures after the manner of most of the service cartridges of the present day. It was for use in the Maynard breech-loader and had some very good points. In 1860 many of these cartridges were made at the Frankford arsenal, where a head in the shape of an attached disk was soldered on. In 1858, G. W. Morse patented a metallic shell centre primed cartridge with an anvil in the shape of a forked wire with the legs soldered to the sides of the shell, the intersection of the two legs being the point to receive the blow. This cartridge had a rubber packing in the head which surrounded and supported the capsule containing the fulminate, the latter fitted over the anvil. But the advantage of the centre

primed cartridge was not fully understood till some years later, the rim-fire Spencer being used in the repeater of that name during the war of the Rebellion, and in the Henry repeater also. The rim-fire cartridge proved itself to have the property of providing a good gas check, and the capability of being moved in the magazine and loaded into the chamber without requiring the use of complicated mechanism; but it was defective in that it required a comparatively large fulminate charge to fill the rim-space, and that the fulminate was not always evenly distributed, defects that in the one case caused a great strain on the head, often enough to burst it, and in the other frequent miss-fires.

When the war of the Rebellion proved that the breech-loader was the arm of the immediate future, it gave an impulse to the improvement in metallic cartridges that resulted in the great activity that was displayed in that direction, especially in the United States from 1864 to 1872. The best talent of the Army Ordnance Corps gave the subject its attention. Cols. Treadwell, Laidley, Benét, Benton, and Crispin, and Capt. Prince, experimented and made researches in this direction, with results that speak for themselves in the many excellences of the cartridges now manufactured at the Frankford arsenal. In this period appeared the Martin folded, the Millbank close folded, so-called solid, and the Hotchkiss really solid headed shells, and the Berdan, Farrington, and many other excellent primers; immense works for the manufacture of small arm ammunition were established, a great industry was created, and the American centre primed metallic cartridge came into existence to challenge the admiration of the world. All nations that pretend to maintain a fighting force use to-day the American small arm ammunition, either manufacturing it themselves or obtaining it from this country; but there is very great difference of opinion as to the comparative excellence of certain points. It is generally conceded that the cartridge case shall be of the drawn metal centre primed type*—even conservative Eng-

*The cartridge shell best adapted to navy use seems to be one of the solid-head outside primed type, of copper, of "the copper lined," like that manufactured by the Coe Manufacturing Company, or of brass, nickel plated or otherwise protected from corrosion; solid head because the extraction is freer than with the folded one, an important consideration when the ammunition is to be used in magazine and machine guns; outside primed, because it can be reloaded aboard ship and thus materially reduce the expense of target practice; and of the metal or metals as mentioned, because experience has shown that the brass shell

land being on the point of giving up her wrapped metal Boxer shell, a shell experimented with and patented by Gen. Rodman and Col. Crispin, in 1863, and by them rejected as inferior to drawn metal; but the questions of copper or brass, folded or solid heads, canalured bullets with lubricant in canalures or smooth bullets with paper patch and wad lubricant, kind of primer, kind of lubricant, shape of body, cylindrical or reduced (bottled), shape of bullet and proportion of powder charge to weight and shape of bullet, have never been settled, although there has been much investigation in this direction, while the wide field of determining the character of the powders to be used with bullets of different weights and calibres is neglected and unworked.

To return to the repeater; as has been shown, the practical modern repeater only awaited the advent of metallic ammunition, and as may be supposed appeared with it. In March, 1860, the Spencer repeater was patented, and the Henry in October of the same year. The first of these guns, with a magazine in the stock and a breech-block swinging downward and backward by the action of a guard lever, was the favorite cavalry arm of the war of the Rebellion, many thousands of them seeing service in the hands of the mounted troops of the United States and in the navy; while the second, with a magazine under the barrel and a guard lever operated, backward sliding, breech-block, was also extensively used by the cavalry in the same war. Both these guns were excellent arms, and even in the light of recent developments one can only say that as military repeaters they were perhaps defective in using lever-worked breech-blocks instead of sliding bolts; in the position of the loading orifices of the magazine—that in the one being in the butt plate, and in the other near the muzzle; in using rim-fire ammunition, and, in the Henry, in leaving the magazine exposed to the entrance of rain, dust, sand, and mud. After the war of the Rebellion, so great was the activity displayed in working out the repeater idea that, in the United States alone, the number of patents issued for devices of this kind, in the period extending from 1873 back to 1836, reached 120, most of which were brought out later than 1865. Since 1873, many more have been added to the list, the greater number crude and worthless as patented, "mere baubles," in the language of the cynical Pepys, but nearly all containing ideas that,

is not to be relied on after being stored in a ship's percussion locker for a couple of years. The copper-shell, folded head cartridge of the Frankford arsenal is a most excellent one, but it cannot be reloaded and its extraction is difficult. Neither of these objections apply to the Frankford reloading cartridge.

in combination with those of other guns of the type, result in practical arms. The "growth" of the well-known Winchester repeater is illustrative of this combination of principles. The origin of the Winchester was the Jennings, a bolt gun, with an under barrel magazine, patented in 1849. The next year the patent was bought by Smith and Wesson, who manufactured the guns and adapted them to use the wooden shell unprimed cartridges invented by Walter Hunt in 1848. Smith and Wesson spent five years in improving the gun, applied to it several patented devices, and then, in 1855, sold it with its patents to the Volcanic Repeating Arms Company, which was organized to manufacture guns and pistols on the Jennings plan, adapted to use the loaded bullets patented by Smith and Wesson in 1856. The Volcanic Repeating Arms Company tried for two years to bring the gun up to a practical standard, made some improvements, and then went into insolvency. The gun with its improvements was then bought by the New Haven Arms Company, organized to manufacture it, who in turn spent two years and much money in improving it, and eventually, in 1860, produced through the superintendent of the company's works, Mr. B. F. Henry, the Henry repeater.

The Jennings gun had been improved past recognition. The Henry was improved, in 1866, by Mr. Nelson King, who replaced the magazine in one with the barrel, opened slotted its whole length. It was arranged to load by dropping the cartridges in near the muzzle after pushing the feed spring up into a cap which swung clear of, and opened the magazine, by a tubular one that received its charges against the spring through an orifice in the breech. This gun of many ideas was named the Winchester, after the president of the company, which was reorganized under the name of the Winchester Repeating Arms Company, and which has since manufactured the arm, acquiring the patents of Fogerty and Spencer, in order to suppress the making of guns of those names. In 1873 the gun was remodeled to take centre primed ammunition, and then became the Winchester repeater as we know it to-day.

During the last decade, the military authorities of the world have been seriously considering the adoption of the magazine gun as a standard arm for mounted troops and men serving afloat. As regards this country, the army has been asking for a magazine arm with which to meet the Indians often armed with that favorite weapon of the frontier, the Winchester, and the request has been met by the War Department by ordering, in 1877, a board of ordnance officers to select and recommend a magazine gun for the military service. This

board in the following year tested* and experimented with some twenty systems brought before it, and reported as follows:

"The board, in the discharge of these duties, has tested all the guns presented uniformly and in the manner that seemed to it best

* The board, after discussion, adopted the following rules and tests for the trial of all magazine guns submitted under the order:

The piece to be first fired ten rounds by the exhibitor, as a test of safety; the same firing to be also a test of rapidity by one familiar with the arm. The time to be noted in the record.

The firing to be then continued according to the rules annexed, by an employé of the armory, or soldier detailed by the War Department.

The service-cartridge to be used in all cases.

No persons will be admitted to the firing-ground but the agents or exhibitors of the gun immediately under trial, and such other persons as may be specially invited by the board.

The handling of guns by their representatives at *any* time after the preliminary tests for safety is *forbidden*.

Any arm which has been submitted to the board and entered upon the record, shall remain in the hands of the board for such time as may be necessary to make drawings explanatory of its mechanism.

If a gun become disabled or unserviceable, all further tests will be discontinued, and the proprietor informed of the fact. If the gun be altered and resubmitted to the board, it will be treated as a new gun.

REGULAR TESTS.

Safety tests: To be fired ten rounds by the exhibitor or with a lanyard.

I.—Rapidity with Accuracy.

The number of shots which, fired in two minutes from the gun—both as a magazine-gun and as a single shooter—strike a target 6 feet by 2 feet at a distance of 100 feet. Any cartridges missing fire in this or other tests to be tried with a prick punch, or opened to ascertain the cause of failure. The test to be begun with the chamber or magazine filled; other cartridges to be disposed at will on a table.

II.—Rapidity at Will.

The number of shots which can be fired in one minute, irrespective of aim, under the same circumstances as in Test I.

III.—Endurance.

Each gun to be fired 500 continuous rounds without cleaning, using the magazine. The state of the breech mechanism to be examined at the end of every 50 rounds.

adapted to determine the question of their suitability for the military service, as well as to determine their comparative merits in that respect.

IV.—Defective Cartridges.

Each gun to be fired once with each of the following defective cartridges: 1. Cross-filed on head to nearly the thickness of the metal. 2. Cut at intervals around the rim. 3. With a longitudinal cut the whole length of the cartridge, from the rim up. A fresh piece of white paper, marked with the number of the gun, being laid over the breech to observe the escape of gas, if any occur.

V.—Dust.

The piece to be exposed in the box prepared for that purpose to a blast of fine sand-dust for 2 minutes; to be removed, fired 20 rounds, replaced for 2 minutes, removed and fired 20 rounds more.

VI.—Rust.

The breech mechanism and receiver to be cleansed of grease, and the chamber of the barrel greased and plugged, the butt of the gun to be inserted to the height of the chamber in a solution of sal-ammoniac for 10 minutes, exposed for two days to the open air standing in a rack, and then fired 20 rounds.

VII.—Excessive Charges.

To be fired once with 85 grains of powder and one ball of 405 grains of lead; once with 90 grains and one ball, and once with 90 grains and two balls. The piece to be closely examined after each discharge.

Supplementary Tests.*

1st. To be fired with two defective cartridges, Nos. 1 and 2, and then to be dusted five minutes, the mechanism being in the mouth of the blow-pipe, and closed, the hammer being at half-cock; then to be fired 6 shots, the last two defective Nos. 1 and 2; then without cleaning to be dusted with the breech open, and fired 4 shots. The piece to be freed from dust only by pounding or wiping with the bare hand.

2d. To be rusted for 4 days after immersion as before, then fired 5 rounds with the service cartridge; then without cleaning to be fired 5 rounds with 120 grains powder and a ball weighing 1200 grs.; the gun to stand twenty-four hours after firing without cleaning, and then to be thoroughly examined.

3d. Facility of manipulation by members of the board.

4th. Liability to accidental explosions of cartridges in the magazine.

Additional tests may be made by the board to clear up doubts raised by previous trials.

*To be applied only to such arms as have passed through the regular test in a manner satisfactory to the board.

"The regulations for the trials adopted by the board are given in the appendix.

"Its experiments to test the liability of accidental explosion of cartridges in the magazine seem to show that there is little probability of such explosion when using the inside-primed service-cartridges, or even with the exterior-primed cartridges direct from the factory, when fabricated and inspected with the care and attention usually given them. With cartridges reprimed in the field or garrison, risks may be introduced which have not come within the scope of the investigations of the board.

"From the satisfactory manner in which the Hotchkiss gun, No. 19, has passed these tests, and from its combination of strength, simplicity, and great effectiveness as a single loader, the board is of the opinion that the Hotchkiss gun No. 19 is suitable for the military service, and it does, therefore, recommend it as such."

Signed: J. G. BENTON,
Lieutenant-Colonel of Ordnance, President of Board.
F. H. PARKER,
Major of Ordnance.
J. P. FARLEY,
Major of Ordnance.

In 1879, a thousand Hotchkiss guns were issued to the army for trial in the field, and in the same year the Naval Bureau of Ordnance adopted the same gun for the standard shoulder-piece, and at the same time took a few Remington-Keene and ordered a few Lee guns for trial. In 1880, the current year, the Interior Department ordered a thousand Remington-Keene guns for use in the hands of the Indian police. General Miles has requested that the troops under his command be armed with the Lee gun, as he considers it the best known arm for Indian fighting.

England has been awaiting the advent of a magazine arm adapted to the awkward Boxer cartridge, and will wait long if the reason for delay continues to hold good.

France has adopted the Kropatschek for its navy, and intended to take fifty thousand of these guns for use afloat, but has lately concluded to use them only experimentally and has but two thousand in service.

Russia had a few Evans' guns a half dozen years since, and is now experimenting upon magazine guns.

Germany is doing nothing in this direction.

Austria has adopted the Fruwirth gun for its navy, and has forty thousand of them in the hands of its shore troops who guard the frontier, doing customs work, etc. The government is also experimenting with the Vetterli.

Italy has adopted the Winchester for its navy, and has made a few thousands of the guns at Venice. For shore service the government is endeavoring to convert the single loading Vetterli into a magazine gun on the plan of Capt. Bartolemeo.

Turkey has the Winchester for it cavalry.

Switzerland has adopted the Vetterli magazine gun, and is the only country which has thus far put a repeater into the hands of the infantry of the line.

Norway has introduced the Krag-Petersen into its navy. The writer has been unable to learn that any other countries are doing anything in the way of adopting magazine arms. All the military repeaters now in use, except the Winchester, are of the sliding bolt type of breech-block, and all of them, except the Hotchkiss and the Lee, have magazines under the barrel.

The weight of the military opinion of the world seems to decide, at present, that the repeater shall be used as a single loader for ordinary fighting, with the charged magazine held in reserve for critical moments; that it shall be so devised as to be capable of being so used; and that as a single loader it can be as easily manipulated and as rapidly fired as any gun on a single breech-loading system; that the breech-block shall be of the bolt type, that the piece shall be so constructed that the magazine and all working parts connected with it may be disabled without detracting from the usefulness of the arm as a single loader; that, other things being equal, same number of charges in magazine, etc., the centre of gravity of the charged magazine shall fall between the rest hand and the shoulder of the man firing the gun; that the magazine shall be capable of taking and the gun capable of firing cartridges of different lengths; and that it shall be readily and rapidly charged.

The fact that so many military repeaters have tip stock magazines, bad as regards position, is due to the desire for greater stowage capacity than one in the butt stock will furnish without making the piece very clumsy.

Classification of Magazine Arms by Board of United States Army Ordnance Officers, 1878.

Classification of magazine-arms, founded on the method by which cartridges are fed from the magazine.

- **Magazine-arms** — supply chamber with cartridges from—
  - 1st, butt-stock
    - 1st, by a spring
      - 1st, direct — Hotchkiss. Lewis-Rice. Spencer.
      - 2d, indirect
        - 1st, by rotating barrel about axis parallel to it into line with magazine — Scott and Triplet
        - 2d, to position opposite receiver — Clemmons.
    - 2d, by a ratchet, which is—
      - 1st, automatic — Chaffee.
      - 2d, operated by hand — Springfield-Miller.
    - 3d, by a spiral cam (screw-motion) — Evans.
  - 2d, tip-stock
    - by a spring—
      - on a carrier which is—
        - 1st, sliding, at right angles to axis of bore — Winchester. Henry. Hunt. Vetterly.
        - 2d, rotating—
          - 1st, to position oblique to axis of bore — Burton. Ward-Burton. Sharps. Remington.
          - 2d, to position parallel with axis — Tiesing. Burgess.
        - 3d, sliding and rotating — Buffington.
  - 3d, magazine on top of barrel — by a spring— to position parallel to axis of bore and above receiver— and by gravity into line with axis of bore — Franklin.
  - 4th, magazine below bolt — by a spring (vertically)— to position opposite center of chamber — Lee.
  - h, revolving chambers — Hodges. Colt's repeat'g-rifle. Revolving pistols.

Classification of all magazine-guns before the Board, founded on the motions of the principal part by which the breech is opened and closed.

- Breech-loading small-arms have—
  - fixed chambers closed by—
    - movable breech-blocks which are—
      - 1st, sliding
        - in line of axis of barrel by—
          - 1st, direct action, *i. e.*, bolt-guns having—
            - 1st, concealed locks ..... Hotchkiss. / Remington. / Burton. / Ward-Burton. / Franklin. / Lee. / Sharps Rifle Company.
            - 2d, center locks ..... Hunt.
          - 2d, indirect action *i. e.*, moved by levers from—
            - below ..... Winchester. / Burgess. / Tiesing.
      - 2d, sliding and rotating ..... Buffington. / Chaffee.
      - 3d, rotating about an axis—
        - at 90° to axis of barrel, and—
          - horizontal, lying—
            - 1st, above axis of barrel, and in—
              - front ..... Springfield-Miller. / Springfield-Clemmons.
            - 2d, below axis of barrel, and in—
              - front, moved from—
                - below (by a lever) ..... Lewis-Rice.

In preparing this article I have consulted and extracted from the United States Army and Navy Ordnance Reports, the United States French and English Patent Reports, and the writings of Col. Colt, Col. Church, MM. Paulin Desormeaux, and others. I am indebted for aid and information to Gen. W. B. Franklin, Mr. C. M. Spencer, and Mr. T. G. Bennett, Secretary of the Winchester Repeating Arms Co. I do not feel at all sure that the specimens I have selected as illustrative of the different steps are the earliest or latest of their type, or that they best fulfil the duties assigned them; my endeavor has been, by the use of references at hand, simply to indicate in a very general way the development of the magazine gun idea from its inception to the present day.

HARTFORD, CONN., June, 1880.

Since the foregoing paper was prepared there has been a marked forward movement toward the general adoption of magazine rifles.

Germany has experimented with several, and at one time seemed to favor the Loew system, similar to, if not identical with one brought out by Lee some years ago; it consists of a detachable magazine that grasps the piece forward of the trigger guard; its advantage is that it can be readily applied to any single loading bolt-gun; its disadvantages are that when upon the piece it is very awkward, and when detached very clumsy for transportation upon the person. England is asking for a good butt-stock magazine, lever-action carbine, and has shown a little inclination toward the Martin-Spencer, a gun like the old Spencer in general principles, but charging the magazine through the receiver instead of through the butt-plate. Nearly all European countries are searching for economical systems upon which to convert the single loaders at hand into magazine arms. China is at present taking five thousand Hotchkiss rifles, and the Argentine Republic is endeavoring to decide upon the magazine arm to be procured in this country for the arming of her cavalry.

The United States Navy has just taken a thousand new model Hotchkiss rifles, of which the new modeling consists in replacing the side cut-off and bolt-lock by two parts, one on either side of the receiver, and in fitting the receiver into the stock differently; these changes make the gun stronger in those places where in service it had been found weak.

The army has purchased no magazine arms since it took a thousand Hotchkiss carbines about two years ago; these arms have gener-

ally given satisfaction to the people into whose hands they were put when magazine arms were desired. The stocks have broken badly, owing to an inherent weakness in that point—a defect that has now been eliminated. By authority of congress an army board made up of officers of all arms of the service is to meet in New York next July to investigate magazine gun systems, and recommend the one or two best adapted for use in the army.

In my opinion the Hotchkiss possesses more of the desiderata of a magazine arm for the navy than any other at present procurable.

The Lee system is very attractive in that it allows the shipping of a charged magazine in the same time that it would take to put a single charge into any kind of a tube magazine or into the receiver of a single loader; and in that it allows the transportation of ammunition upon the person, in the magazine, as conveniently as in any other way, and consequently allows the use of several magazines for each piece. Further, the detaching of the magazine removes all chance of the disabling of the piece as a single loader, through accident to the repeating parts, and renders unnecessary some of the more complicated and delicate parts of the ordinary magazine systems, viz. cut-off and cartridge stops; on the other hand, this detaching renders the magazine liable to be lost, but this liability is so small that the advantages of the detaching plan would seem to greatly outweigh it.

Unfortunately, owing to business complications among the owners of the gun, no one has yet been able to obtain any considerable number of Lee arms, and the three hundred ordered for trial in the navy have not yet been made, although the order was given nearly two years ago.

NATIONAL ARMORY, SPRINGFIELD, MASS., March, 1881.

NAVAL INSTITUTE, ANNAPOLIS, MD.

NOVEMBER 4, 1881.

REAR ADMIRAL C. R. P. RODGERS, U. S. N., in the Chair.

AIDS TO NAVIGATION.

BY LIEUT. COMMANDER F. E. CHADWICK, U. S. N.

It is difficult to realize that in 1816, one of the most important lights on the coast of Great Britain, that of the Isle of May, was but an open coal fire on the top of a tower; that until 1809 the famous Eddystone was lighted by twenty-four tallow candles, burned in a lantern without reflectors or any other means of increasing their intensity, and that preceding 1780 there was nowhere any brighter means of lighting than these.

At this last date came together the inventions of the parabolic reflector as applied to such purposes, and the argand burner: these were the beginning of a revolution in the systems of coast lighting, though their application was slow, due partly to the fact that there was under the best of circumstances nothing like the present interchange of scientific thought or discussion, and partly to the almost incessant wars and social upheavals of the period, which generated intense national antipathies and paralyzed international intercourse.

The honor of these advances in lighthouse illumination is due to France, as is that of most of the succeeding ones of prime importance. The work of Argand and Teullère was perfected by Augustin Fresnel (the elder of two brothers, both of whom achieved eminence in lighthouse engineering), when in 1822 he first used what is known as the Fresnel lens. Perhaps it may be wrong to say that Fresnel was the inventor, as Buffon, the great naturalist, had proposed to grind out of a solid piece of glass a lens in steps or concentric zones, and

Condorcet in 1773 suggested the building of such a lens in separate pieces: Sir David Brewster also published in 1811 an account of such a mode of construction; but Fresnel's invention was made independently and in ignorance of all these, and went beyond them also in determining the radius and centre of the curvature of the generating arc of each zone, instead of having the surfaces zones of concentric spheres. He was thus original in the methods actually employed, and fairly has the reputation due the first practical designer and user.

In 1783 the improved system of reflectors and burners was applied to the tower of Cordouan at the mouth of the Gironde river, France, though some experiments had been made at smaller lights a little earlier. The year preceding, this lighthouse, the finest architecturally considered in the world, had been fitted with eighty flat wick lamps, with segments of spheres as reflectors, "but the light was so poor that mariners earnestly requested a return to the preceding system of a coal fire, the latter having been substituted for a wood fire some years before."*

Scientific lighthouse illumination is thus the growth of the last hundred years. The changes may be divided into three periods: that of the Argand burner with parabolic reflector (1780); the Fresnel lens and multiple burner (1822); and the application of gas and electricity in our own day. Changes too have taken place in oils as well as in lenses and burners, the sperm oil of the early part of the century giving way in this century to lard oil, and now this and the colza and olive oil of Europe are alike yielding in a great degree to mineral oil, which is much more convenient in use, much less expensive, and gives better general results.

The growth and management of our own lighthouse system is of course the most interesting to us. It is instructive as showing how from want of system and foresight a small government organization in a country like our own, whose extent, population and necessities have so wonderfully expanded, may become a monument of inefficiency, and indeed must, where the question to be dealt with is a scientific one and it is left to the haphazard control of the officeholder. It required the efforts of nearly twenty years on the part of a few public spirited men, in the face of bitter struggle and opposition, to lift the establishment to a plane where it had opportunity for its proper development. The change finally came in 1852, and to no one is the

* Illumination and beaconage of the coasts of France.

honor of this great and radical reform due so much as to Rear Admiral Thornton A. Jenkins, whose earnestness and ability in this matter deserve every recognition.

The earliest authentic date that can be used in connection with our lighthouse system is that given by Mr. A. B. Johnson, chief clerk of the lighthouse board, in his excellent paper on our Lighthouse Establishment in Appleton's Annual Cyclopedia for 1880. This is found in a petition dated March 9, 1673, from the citizens of Nantasket, Massachusetts (now Hull), for the lessening of their taxes, because of the material and labor they had expended over and above their proportion in building a beacon on point Allerton, near the entrance to Boston harbor. It appears this beacon was lighted, at least at times, by fire-balls of pitch and oakum, which were burned in an iron grate on top.

"The first lighthouse properly so-called on this continent was built at the entrance to Boston harbor, on Little Brewster island, in 1715–16, at a cost of £2285 17s. 8½d. It was erected by order and at the expense of the general court of Massachusetts bay, and it was supported by light dues of 1d. per ton on all incoming and outgoing vessels except coasters, levied by the collector of imports at Boston."* Seven others were built before the Revolution, presumably by the colonies in which they were situated and when circumstances were such that attention could once more be given to peaceful things. Congress, to whom by the constitution of the new republic the power to regulate commerce was granted, passed an act in August, 1789, whereby the general government took upon itself the support of all lighthouses, beacons and buoys to be established, and of all lighthouses which had been previously maintained by the several states, and which should be ceded by these states to the United States. Acts of cession were passed by the several states, and the federal authority became responsible for the entire support of aids to navigation within our borders. There were at this time the following lights in existence, and I give the dates of their establishment as far as I can determine them: Portsmouth, New Hampshire, date unknown; Little Brewster island, near Boston, 1715; Gurnet, near Plymouth, 1769; Brant point, Nantucket, 1746; Beaver Tail, near Newport, Rhode Island, 1761; Sandy Hook, 1764; Cape Henlopen, date unknown; Charleston, South Carolina, 1767.

*Appleton's Annual Cyclopedia. A. B. Johnson.

The act regarding the transfer of the lighthouses likewise designated the secretary of the treasury as the controlling officer. In 1792 the office of commissioner of the revenue was established, and under the secretary of the treasury he was made general superintendent of lights; the collectors of customs acted as local superintendents in their own customs districts, and were supposed to look after the supply of oil, to exercise a certain authority over contractors, and to make a yearly inspection of the lights. The office of commissioner of the revenue was abolished in 1802, and the secretary of the treasury, then Mr. Gallatin, resumed the general superintendence of the lighthouse establishment, and it was so held until 1813, when the office of commissioner of the revenue was re-established. In 1817 there was a second abolition, the act to take effect in 1820, and in this latter year the superintendency fell to the fifth auditor, Mr. Stephen Pleasanton, who held the position for the long period of thirty-two years, or until the present establishment was organized.

In March, 1812, an act had been passed authorizing the secretary of the treasury to contract with a Mr. Winslow Lewis for the fitting and keeping in repair all the illuminating apparatus of the lighthouses the United States, at the same time purchasing his patent right to the "new and improved manner of lighting lighthouses by reflecting and magnifying lanterns." The first contract was for seven years, but it was afterwards extended, and for more than thirty years Mr. Lewis was the foremost figure of the establishment; building and repairing the lighthouses or altering the character of the lights much at his own discretion. The patent referred to was one which ought never have been granted, as there was not any pretence that the reflectors were other than the parabolic reflectors in use for years in Europe, and the magnifying lenses were simply heavy glass bull's-eyes, in some cases four inches thick, which, instead of increasing the intensity of the light, diminished it enormously. Nothing can show more decidedly the low state of scientific knowledge in this country at that time, and especially the want of it on the part of the superintending authority of the lighthouse establishment, than the fact that such a patent could be granted and an application of it made in our lighthouses.

The following letter from Mr. Pleasanton to Mr. Lewis gives an example of the loose management which existed under the former's administration, and shows how fully the establishment was in the

hands of an individual upon whom there was practically no governmental check whatever:

FIFTH AUDITOR'S OFFICE, Dec. 15, 1835.

Sir:—I perceive by a Mobile paper which I received this morning, that the Mobile light has been refitted by you as a revolving light. As the Pensacola light is a revolving light, and not many miles distant from that at Mobile point, the changing of the latter from a stationary to a revolving light is complained of as an injury to navigation.

In my arrangement with you for fitting up the Mobile point light last summer, it was not expected, nor contemplated, that you would refit as a revolving light, and I am very sorry you have done so.

Will you be good enough to state to me the reasons for changing this light from a stationary to a revolving light?

I am, &c., S. PLEASANTON,

Fifth Auditor and Acting Commissioner of the Revenue.

WINSLOW LEWIS, Esq.

Mr. Lewis answers at length, simply endeavoring to show that what he had done was the proper thing to do in his own judgment and in that of many others. There is no sign that he considered there was any higher authority than himself.

Lighthouses had increased rapidly: in 1820 there were fifty-five; in 1837 there were two hundred and eight, and twenty-six floating lights. Congress had evidently granted almost every application. There was no scientific selection of sites, the lights being established chiefly at the petition of individuals. The building was given out by contract, Mr. Lewis being the largest contractor and builder; his lamps and reflectors were still in use, and in the whole twenty-five years of his connection with the building, repairing and fitting of lighthouses there had been not one step in advance, except that the greater number of his "magnifying lenses" had been removed and the lights allowed to show naturally. Lighthouses were established or changed without any notice to mariners; the lighting of so important a light, for instance, as Barnegat being advertised simply in the paper published at the little village of Egg Harbor; and the fifth auditor, upon complaint being made by ship owners of this want of notice, states in his official answer, that "it would occur to any other persons than those making the complaints that it would be more proper as interested parties for them to give the necessary notice to vessels in which they are concerned."

Mr. Pleasanton's own ideas of what lighthouses should be are given in a rebuttal of some complaints made about this period; they are

curiously crude, to apply to them the mildest designation possible. He says: "The lighthouses I have caused to be built have been planned by men perfectly acquainted with the subject, and consist generally of four classes, viz. the largest class are sixty-five feet high, diameter twenty-five feet at base, graduated to twelve feet at top; deck fourteen feet; lantern sufficient to contain twenty-one lights, fourteen by twelve inches. The second class are fifty feet high, twenty-two feet diameter at the base, eleven feet at the top, deck thirteen and a half feet, walls four feet thick at base, two feet at top; lantern sufficient to contain twenty-one lights, thirteen by twelve inches, in each octagon," and so on, the third class forty feet high, the fourth thirty. He also says: "Experience has shown that a lighthouse higher than sixty-five feet in all our southern country where the coast is low, would be entirely useless, as during the summer months particularly a haze or mist is found to arise from the ground and float in the air at the distance of eighty or ninety feet, and by having a lighthouse sixty-five feet with a lantern ten feet, the light appears below the mist and is seen with its natural brilliancy a great distance at sea; whereas if the tower was carried one hundred feet or more the light would be entirely obscure." This sage observation must have been overlooked by our lighthouse board, as our southern coast is now dotted with lofty towers of more than one hundred and fifty feet, and no complaints have been heard on this score.

Of course so loose a state of affairs as these statements show could not remain without notice, and Nov. 30, 1837, we find a communication from Messrs. E. & G. W. Blunt, of New York, to the secretary of the treasury, giving in greater detail than can be found in any other paper of the date, the shortcomings of the system. The lamps were complained of as poor, the reflectors as of various and irregular shapes, and as not properly adjustable. At Watch Hill it is stated that before each light (several lamps and reflectors being set in a frame together in the old catoptric system) there is placed a thick piece of glass, the same as that used for a ship's deck-light, thus showing that even at this date this colossal piece of ignorance, which I have already spoken of, still existed pretty generally; the last in fact did not disappear until 1840. The Blunts' letter also stated that the Watch Hill light, which was revolving with two frames of lamps, had *no* reflectors in one frame and there were several wanting in the other. It also complained of the want of notice to mariners, of the want of proper inspection, of the want of a system of testing oil, and

of the want of a list of lights. Altogether the paper, which no doubt was a truthful representation of affairs, was a very bad showing for the establishment and the country: it ended in asking that the commission of naval officers ordered to investigate the subject of our lighthouse system be extended to the location, construction and management of our lights. The commission referred to was that ordered by the act of March 3, 1837, by which it was ordered that before any of the expenditures authorized in the appropriations of that year for lighthouses should be made, "The board of navy commissioners shall cause an examination to be made for the purpose of ascertaining whether the safety of navigation required any additional facilities, and if so, what is most suitable for each place, and to report their opinion in regard to all such places to the secretary of the treasury, who should proceed with the work recommended; and that if the board should advise that the improvements were not needed, they should not be made, and the commissioners' opinions with the facts should be reported to congress."*

The navy commissioners detailed twenty-two officers to this duty, who made their reports to the board in time to have them embodied in a report by the board itself to congress in the same year. This report arrested the building of thirty-one proposed lighthouses, which in the opinion of the board were considered unnecessary. The navy commissioners concluded their report by suggesting that some "additional measures are desirable for obtaining the necessary information to secure the greatest public advantage for the expenditures which may hereafter be authorized for these purposes."

The report received marked attention by congress, and on the report of the committee on commerce in the senate, to which the subject had been referred, it was enacted, July 7, 1838, "in order that congress may be furnished with more exact information in regard to lighthouses and the lighthouse system, the president is hereby authorized to divide the lake and Atlantic coasts into such districts as he

*The following extract from a letter of the fifth auditor, dated March 10, 1841, to the collector of the port of New York, in which he requests him to issue proposals for the purchase of oil for the lighthouses in his district, will show the primitive method of the establishment in vogue at that time: "The oil of both kinds (summer and winter strained) should be tried by burning a few nights before it is received. Some of the officers of customs could do this at their dwellings and determine the quality of that offered."

may deem expedient; and he shall appoint a naval officer or officers, if the public service will allow of it, to survey and examine each district with reference to all the objects aforesaid; and it shall be their further duty to inspect all the lighthouses, light-boats, beacons, buoys, etc., and to report upon their present condition and usefulness; also to inquire and report whether the present public emergencies require any, and if any, what further additional works and improvements of the above description, and of what kind; and also further to report whether in their judgment the public interest requires any modification of the system of erecting, superintending and managing the lighthouses, light-boats, etc., and if so, in what particulars; and each board shall report separately on all these matters, which reports shall be laid before congress." Under this comprehensive act the Atlantic coast was divided into six, and the lakes into two districts, and an officer of the navy detailed to each. Elaborate reports were made by them, which were practically a severe reflection upon our system, and showing a much needed change. The first forward move was made in August of the same year, when Captain Matthew C. Perry, under authority of the treasury department, and by order of congress, expressed in another portion of the act just mentioned, purchased of Lepaute, Paris, two sets of Fresnel lens apparatus, which were erected after much delay at the Highlands of Navesink. Captain Perry also made a very interesting report on the lighthouse systems of England and France, which was published in compliance with a resolution of the senate of July 20, 1840.

The public mind had become educated on the subject beyond that of the authorities in charge of the establishment, and complaint, inquiry and explanation became more and more frequent. If Mr. Pleasanton was satisfied, the secretary of the treasury was not; and at the latter's request in 1842 an appropriation of $4000 was made, under which Mr. I. W. P. Lewis, a civil engineer of eminence, was commissioned by Mr. Forward, then secretary, to inspect and report upon the condition of the lights and lighthouses of our coast. His report of his inspection of seventy lights, published in 1843, in compliance with a resolution of the house of representatives, was a most scathing showing of inefficiency, and had the effect of raising such an opposition and clamor on the part of those interested in the retention of the existing state of things, that his inspection never went farther. The fifth auditor, in a letter of Jan. 3, 1844, to Mr. Spencer, Mr. Forward's successor as secretary, speaks of the "lighthouse estab-

lishment and its management in the states of Maine, New Hampshire, and Massachusetts having been grossly misrepresented by a man (I. W. P. Lewis) employed by your predecessor to inspect the same." These representations, in spite of the protestations of the fifth auditor, were fully borne out by later boards, which show Mr. Lewis to have acted in the most honest and fearless manner; that the construction of the lighthouses was of the rudest and most blameworthy description; that the work had been slighted in every possible way by the contractors; that, for instance, the three lighthouses at Nauset on Cape Cod, built of brick, had no foundation whatever, being built directly on the surface of the ground, and that the inner and outer courses of brick-work had been filled in with loose bricks, stones and sand. To quote his words: "The lanterns containing the lamps and lantern reflectors are by far the most curious parts of the lighthouse establishment. They are all on one uniform model, differing only in magnitude—octagonal on the plan the height of the sides being about equal to the diameter at the angles. The frames are very ponderous, of wrought iron, and containing by a fair estimate three times the quantity of material requisite. The angle-posts are two inches square, and with the sashes attached, the width of the angles is increased to four inches; the sash bars are one inch wide, and the glass mostly 10×12 inches square (excepting a few fitted up quite recently, which were copied from the improvements made at Boston light), and of the most impure kind, full of striæ and veins, so that what light escapes from its iron cage is refracted in all directions by the effect of the glass, and but a small portion reaches the eye of the observer." He also found the reflectors of various and irregular shapes, badly made and badly kept; the lamps were in equally bad condition; the want of care by the keepers and the inefficiency of the buoyage, &c., were also shown.

This report, made by a man who evidently had knowledge of the subject, was the cause of a most acrimonious discussion, and the result was that in 1845, Lieutenants Thornton A. Jenkins and Richard Bache of the navy were detailed, at the request of the secretary of the treasury, the Hon. R. J. Walker, to examine and make a report upon the lighthouse systems of Europe, so that there might be some definite means of comparison between our own system and those abroad. The report of these officers, dated June 22, 1846, was elaborate and exhaustive, and its recommendations contain the germ of our present lighthouse organization.

In appropriations for the service in 1849, it was provided that "in all cases where preliminary surveys are necessary to determine the site of a proposed lighthouse or light-boat, or to ascertain more fully what the public exigency demands, the secretary of the navy shall thereupon appoint one or more officers of the navy, not under the grade of commander, to perform the required service; or when the expenditure is to be made under the direction of the bureau of topographical engineers, the secretary of war shall appoint one or more officers of the corps of topographical engineers, possessing the requisite skill and experience to perform like service." The army engineers had been employed on occasional works of exceptional difficulty since 1838, and the act regarding appropriations of 1847 particularly mentioned six constructions of this class which should be built under the superintendence of the topographical bureau.

The reports of Lieutenants Jenkins and Bache, and of the other naval officers who under the several acts mentioned had examined the lighthouses of the coasts and lakes, had as result the passage of secs. 8 and 9 of the act for the appropriations, &c., for lighthouses, approved March 3, 1851, that "The secretary of the treasury is hereby authorized and required to cause a board to be convened at as early a day as may be practicable after the passage of this act, to be composed of two officers of the navy of high rank, two officers of engineers of the army, and such civil officer of high scientific attainments as may be under the orders or at the disposition of the treasury department, and a junior officer of the navy to act as secretary to said board, whose duty it shall be, under instructions from the treasury department, to inquire into the condition of the lighthouse establishment of the United States, to make a general detailed report and programme to guide legislation in extending and improving our present system of construction, illumination, inspection and superintendence. . . .

"Sec. 9. And be it further enacted, that the president be and he is hereby required to cause to be detailed from the engineer corps of the army, from time to time, such officers as may be necessary to superintend the construction and renovating of lighthouses."

This board was composed of Commodore Shubrick, U. S. N., Commander Dupont, U. S. N., General Totten, U. S. corps of engineers, Lieut. Col. Kearney, U. S. top. engineers, Professor Bache, superintendent of the coast survey, and Lieut. Thornton A. Jenkins, U. S. N., secretary.

The board made its report Jan. 30, 1852. It was published in a volume of 760 pages, and, says the N. Y. Journal of Commerce of

July 9, 1852, "embodies all the scientific and practical information necessary to the clear understanding of this branch of the public service, hitherto so shamefully neglected and viciously managed. . . .

"In the report just published by the board, who are individually and collectively beyond the merest suspicion of prejudices or bias of any kind, the array of facts is so strong, the deficiencies pointed out are so numerous, and the glaring inconsistencies so clearly held up to view, that the wonder is how such a gigantic system of abuses could so long have escaped discovery and a speedy extermination. And yet the details are for the most part a repetition, on an extended scale however, of the very defects pointed out first by Messrs. Blunt, next by the board of naval officers in 1838, and thirdly in a more explicit and technical form by Mr. Lewis in 1842."

The report of the board was conclusive: it showed an absolute want of system of construction, illumination, inspection and superintendence, and that the whole was about as bad as it well could be. Many pages are taken up by a bare enumeration of defects, and the language quoted from the journal mentioned is none too strong in the light of the report. As an instance, the report states that no argand burners and no reflectors were found at the Sandy Hook light-vessel; all the light-ships were in very bad condition; in two instances they were nearly deserted; in one case both keeper and mate were absent, and in the other there was no one on board but a colored boy of twelve or thirteen years. "Nothing," to quote the report itself, "could be much worse than the floating lights of the United States."

The fifth auditor, in a communication to congress, attempted a rebuttal of the board's statements, but in a reply dated May 7, 1852, the board showed the ludicrous inaccuracy of the effort. The final result was the passage, against much opposition on the part of obstructionists, whose names should be held in remembrance, of the act approved Aug. 31, 1852, by which the president was required to appoint two officers of the navy of high rank, one officer of the corps of engineers of the army, one officer of the corps of topographical engineers of the army, and two civilians of high scientific attainments whose services may be at the disposal of the president, and an officer of the navy and an officer of engineers of the army as secretaries, who should constitute the lighthouse board, of which the secretary of the treasury should be *ex-officio* president. The topographical engineers being shortly afterwards merged in the engineers, both of the engineer officers were appointed from this latter corps, and with this exception

the above is the board of to-day. The law also required that the coast of the United States, including the lake coasts, should be divided into not more than twelve districts, to each of which an officer of the army or navy should be assigned as an inspector, subject to the orders of the lighthouse board, and that such officers as are necessary to superintend the construction and renovation of lighthouses should be detailed from the engineer corps of the army.

The board is required to elect by ballot one of its members as chairman, who shall preside at the meetings when the president is absent; it is also required by law to meet for the transaction of business on the first Mondays in March, June, September, and December, but may be convened whenever the exigencies of the service may demand it. In the intervals the business, under the rules established by the board, is transacted by an executive committee consisting of the chairman and the two secretaries. Both this law of 1852, establishing the board, and that creating the temporary board of 1851, were drafted by Lieutenant, now Rear Admiral, Thornton A. Jenkins, no modification of the original draft being made other than to reduce the proposed number of districts from eighteen to twelve.

The first board of the new organization was as follows: The Hon. Thos. Corwin, secretary of the treasury, president *ex-officio;* Commodore Wm. B. Shubrick, U. S. N.; Brevet Brig. General J. G. Totten, U. S. corps of engineers; Commander S. F. Dupont, U. S. N.; Lieut. Colonel James Kearney, U. S. corps topographical engineers; Prof. Alex. D. Bache, superintendent coast survey; Prof. Joseph Henry, secretary of the Smithsonian Institution; Lieutenant Thornton A. Jenkins, U. S. N., naval secretary; Captain E. L. F. Hardcastle, U. S. corps top. eng., engineer secretary.

The board met for the first time in Washington, Oct. 9, 1852, and Commodore Shubrick was elected chairman. It found a gigantic work before it: nothing less, as it has turned out, than an entire reconstruction of towers, dwellings, and apparatus. There were, upon the assumption of their duties, classed according to actual value: one first class or primary sea-coast light; two second class or secondary sea-coast lights; sixteen third class or bay, sound, lake coast, &c., lights; eighty-seven fourth class or bay, sound, river, and harbor lights; two hundred and sixteen fifth and sixth class or river, harbor and pier-head lights; a total of three hundred and twenty-five. Of these but five had Fresnel apparatus. In addition there were thirty-four light-vessels and (about) twenty-six hundred buoys and beacons.

The following comparison will show the speed with which the establishment had grown.

Date.	No. of Lighthouses.	No. of Light Vessels.
1789	8	0
1820	55	0
1838	210	28
1852	325	34

By the report of the lighthouse board of 1880, there were on July 1 of that year: First order lights, 47; Second order lights, 26; Third order lights, 65; Fourth order lights, 204; Fifth order lights, 128; Sixth order lights, 160; Range lenses, 10; Lens lanterns, 14; Reflectors on lighthouses, 10; Stake lights on rivers, 819; Light ships, 31; Whistling buoys in position, 25; Other buoys in position, 3115; Fog signals, steam or hot air, 57.

This shows a total of six hundred and ninety-five lighthouses and light-vessels, besides the eight hundred and nineteen stake lights, used chiefly on the Mississippi, Missouri, and Ohio rivers. These last were established under a law of June 23, 1874, and have proved of the greatest aid to the commerce of these great highways.

The magnitude of the work done by the lighthouse board since 1852 is shown by the fact that of the three hundred and twenty-five lighthouses turned over to them by the fifth auditor, *all but seventy-one* have been completely rebuilt, and all have been repaired and refitted without exception. This has been done, of course, with vast labor and at large expense; the latter, however, was not as great as might be supposed, as the expense of replacing the reflector lights in the then existing stations by lenticular apparatus was more than covered by the saving in oil.

The coast and lakes were divided into twelve districts, in which there has been but little change, except to add the two districts of the Missouri and Mississippi and the Ohio. The extent of these districts is as follows:

The First from the NE boundary of Maine to Hampton harbor, New Hampshire.

The Second from Hampton harbor to Gooseberry point, Massachusetts.

The Third from Gooseberry point to Squam inlet, New Jersey, including Hudson river and lakes Champlain and Memphremagog.

The Fourth from Squam inlet to Metomkin inlet, Virginia.

The Fifth from Metomkin inlet to New River inlet, North Carolina.

The Sixth from New River inlet to cape Canaveral, Florida.

The Seventh from cape Canaveral to the Perdido river, near Pensacola on the west coast of Florida.

The Eighth from Perdido river to the Rio Grande, Texas.

The Ninth was merged in the Eighth.

The Tenth embraces all the aids to navigation on the American shores of lakes Erie and Ontario and St. Lawrence river.

The Eleventh includes lakes St. Clair, Huron, Michigan, and Superior, and the connecting straits.

The Twelfth is the state of California.

The Thirteenth is the state of Oregon and Washington Territory.

The Fourteenth extends from Pittsburgh to the mouth of the Ohio.

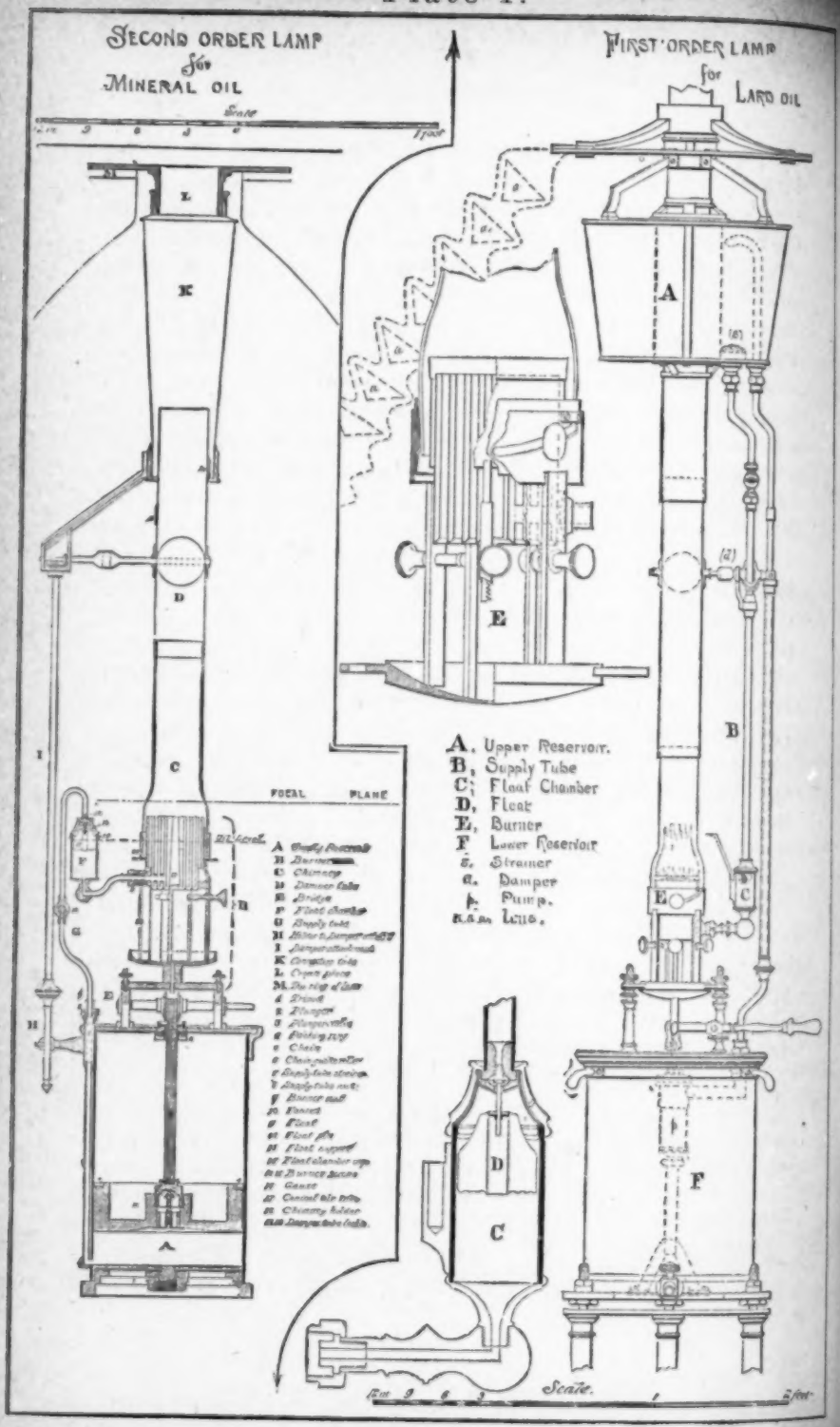
The Fifteenth extends from New Orleans to the head of navigation of the Mississippi and Missouri.

To each of these districts are attached a naval officer as an inspector, who has charge of the inspection, supplies, buoyage, the light-vessels and *personnel* of the district, and an officer of the engineer corps of the army, who has charge of the construction and repair of the lighthouses and dwellings. In the Third district at Tompkinsville, Staten Island, is established the general depot, whence are distributed the supplies of all kinds and the illuminating apparatus. There are here large storehouses for supplies, and a machine-shop in which are manufactured all the lamps used by the establishment, and in which all the lenses are first set up previously to being forwarded to their destination. All oil is here tested before being received as to its illuminating and other properties; every first and second order lamp chimney is likewise thoroughly tested, and a certain percentage of the chimneys of the lower orders. Established in 1860, this depot has grown from comparatively small beginnings to large and important proportions, enabling the establishment, as far as the supply of its more delicate and important apparatus is concerned, to be self-supplying. Mr. Joseph Funck, the foreman of the lamp-shop, is the inventor of the important improvements in the lamps used for the higher order lights, which have made them the most efficient lamps for lighthouse purposes ever invented. Our dependence for some years after the establishment of the present board was upon France. The multiple wick had been invented by Fresnel, and its use was a necessity in lamps of high power, as the intensity of a flame depends not only upon its surface but upon its depth. Various mechanical means were em-

ployed to supply the great amount of oil needed for the support of so large a flame, capillary attraction being altogether insufficient; it was necessary to bring the surface of the oil to the flame itself to prevent the frequent charring of the wick and consequent reduction of the intensity of the light. The favorite French lamp was one in which several small pumps were driven by clock-work, pumping the oil to the required height; some few of these are still in use by ourselves, but the Funck lamp, in efficiency, simplicity, ease of management, non-liability to get out of order, and in cheapness, far surpasses it. The specialty of the lamp is the float which regulates the supply of oil. (See plate I.) In the lard-oil lamps the oil is first poured into the lower reservoir shown in the sketch, and pumped thence into the upper reservoir, whence it descends through the supply tube. The float chamber is placed at such a point that the surface of the oil in this chamber will be at the same level as the top of the burner. This level remains constant through the action of the float, which is lifted by the oil and closes the supply tube when the supply becomes too great. It is thus constantly opening and closing the supply, giving practically a constant level. The draft from the chimney is carried through the upper reservoir, thus keeping the oil warm; a primal necessity in winter, as lard oil congeals at 40° or 45°, and in cold weather must always be heated before it is used. The danger of overheating mineral oil required a modification of this lamp (see plate I), and instead of an upper reservoir from which the oil descends to the float chamber by its own gravity, there is a low reservoir, in which acts a heavy piston, which by its weight forces the oil through the supply tube. The level of the oil in the mineral oil lamp is kept lower than in the lard oil, and it is lifted to the flame by capillary attraction for the distance of an inch and a half, as it will not do to bring its surface in actual contact with the flame. This latter lamp is now rapidly replacing the second and third order lard oil lamps; the entire substitution being expected to take place by October, 1882.

Sperm was the only oil used in this country in the lighthouses until the advent of the present Establishment. Colza, a vegetable oil produced from a species of wild cabbage, largely grown for the purpose in southern Europe, had been adopted in France, and later in England. Olive oil was also used largely by countries where it was produced. The lighthouse board by its desire to adopt the colza oil in this country encouraged the growth of the plant here, and it was soon found that it could be supplied by the home market at a lower

Plate 1.


SECOND ORDER LAMP
for
MINERAL OIL
FIRST ORDER LAMP
for
LARD OIL
Scale
Feet
FOCAL PLANE
A. Upper Reservoir.
B. Supply Tube
C. Float Chamber
D. Float
E. Burner
F. Lower Reservoir
G. Strainer
H. Damper
I. Pump.
K.L.M.N. Lens.
Scale.
Feet

price than sperm. It was finally shown, however, after much experiment, that lard oil was an equally good illuminant with colza, and as it could be produced more cheaply, and as the supply was constant, with no fear of failure, it was adopted. This, however, is in its turn being gradually pushed aside by mineral oil: the substitution has taken place first in the lower orders; all from the fourth orders down are illuminated by a capillary lamp with a round wick. The Funck mineral oil lamp has been adopted for the higher orders, but the lard oil has been retained for the first order lights, as though it has been found that the relative power of mineral and lard oil in the two-wick lamp is 78 and 69 candles, and in the three-wick they are about equal (163 candles), that in the four-wick or first order, the flame of this lamp being 3½ inches in diameter, and 3¾ inches high in the lard oil burner, the mineral oil has not, as yet at least, given as good results as the lard, being but 342 candles to the 400 of the lard oil, and consequently of course has not been adopted for this class of light. The mineral oil used must have a flash-test of 140° and a fire-test of 164°.

To show the difference between this oil and that sometimes sold, I would state that last winter some oil was tested at the lighthouse depot which was a sample of some which had exploded, burning a woman to death at Tompkinsville; the oil had a flash-test of 68°, or it was ready to explode under the most ordinary circumstances.

The attention of the lighthouse establishment was drawn to the subject of mineral oil as early as 1807, as will be seen by the copy of the following letter addressed to the then secretary of the treasury:

PHILADELPHIA, September 14, 1807.

ALBERT GALLATIN, Esq.

Sir:—We have lately received by our ship the Coromandel, from Rangoon, in the kingdom of Ava, a variety of the curious productions of that interesting country, among others, about five thousand gallons of their celebrated earth oil. It is perhaps the best article known for burning in lighthouses, making a very strong, clear, and bright flame, emitting at the same time a great volume of smoak. We take the liberty of offering it to you for the use of the government in the lighthouses on our coast. The price we would leave until by an experiment (which we request you to give an opportunity of being made and reported on) its actual merit compared with the oil at present in use, can be ascertained.

If you approve of it, Sir, the experiment may be made at cape Henlopen. From the opportunity our son, John B. Davy, commander and supercargo of our said ship Coromandel, obtained of a personal and friendly interview with the monarch of the Burman empire and his family, and of opening a new and very inter-

esting intercourse with the chiefs of the government, some important results may arise to our commerce in the eastern world; on this subject it is our intention soon to make some direct communications to the president of the United States. In the meantime we have no doubt of your disposition to promote our endeavors to obtain consumption for so valuable an article of import as the oil proposed, and any communication that you may favor us with on this subject will be very highly esteemed by,

Sir, your obedient and humble servants,

WILLIAM DAVY & SON.

The text of the reply to Mr. Davy I have not at hand, but it could hardly have been very favorable, as sixty years were to pass before our lighthouses began the use of such oil, though by this time we had come to think the "great volume of smoak" not so desirable a quality as it evidently appeared to the writer of this letter.

An attempt was made to use a gas made from rosin as early as 1844, the experiment being made at the light near Wilmington, Delaware; but the difficulty of guarding against accidents to gas pipes when used within reach of larger gas establishments, and the expense and difficulties attending the manufacture at the station itself, have hitherto prevented any but a very limited adoption. Compressed gas is now used in "ten lights at the northern entrance to Currituck sound, North Carolina. This gas is made and compressed at the board's own gas works, and it is carried to each of the beacons in tanks, built into a scow, which is towed by a steam launch." These lights are kept constantly burning, and burn for ten days; no keepers are at the stations themselves, but the whole work of making the gas from the naphtha, of charging the beacons, etc., is done by three men, who are constantly employed on this duty.

The electric light has of course occupied much of the thought of all lighthouse establishments, and it is now in use in several English and French lighthouses, but it is still a question as to whether there is any special advantage in its use. In ordinary weather the present first order lights can be seen as far as the curvature of the earth will permit; in fog no light can be seen, the sun itself being obscured. As we can never hope to make an artificial light as powerful as the sun, the question of the practicability of furnishing a light which will show through a fog may as well be dismissed at once, and the question as to what kind of light can be seen for the greatest number of hours in the year is the one to be decided, and this is one not so easily answered as one may casually think. The extreme whiteness

of the electric light and its deficiency in red rays seem to be a great defect. Very conclusive French experiments seem to show that such deficiency is fatal to the penetrative power of a light. These experiments, made under governmental supervision, are very striking, especially when it will be remembered that from seventy to ninety per cent. or more of the original white light is cut off by the intervention of the red medium. The following is the official report on this subject:

"Five flames regulated in such a way that four of them being covered with glass colored red of copper, silver or gold, they all appeared of the same photometric intensity observed at 0.80 of a metre distance. The intensity had been fixed at 0.005 of a carcel burner, so that the limits of ranges could be reached without going outside the inclosure of the Champ de Mars, within which the experiments were made. The sky was clear, the night dark, and the observers, four in number, reported as follows:*

"1. *At a distance of five hundred metres the white light ceased to be visible, while the red lights, except the red of gold, were still quite bright.*

"2. At seven hundred and fifty metres the same lights remained visible, but the red light was distinct only in the light which was covered by a glass colored very strongly with copper, its absorption being estimated at ninety-nine one-hundredths of the white light."

Other experiments with more powerful lights were made under the same atmospheric conditions, "but it was always found that the intensity of the red lights diminished much less rapidly than the white as the distance increased." The red of copper in every instance was found superior to that produced by any other metal.

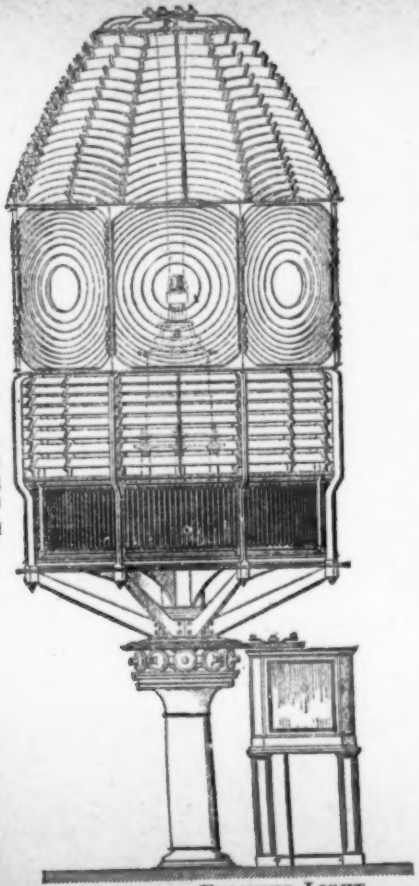
The report of trial in fog is as follows: "The red lights are much superior to the others, because red rays are much less obstructed in their passage through them; the red rays of white lights pass through such fogs, while the others are rapidly absorbed, and green lights, after becoming white, rapidly diminish in intensity. . . . Five reflectors producing white lights of about sixty carcel burners in the axis were observed during fog. The light of the first was uncolored, that of the second red by gold, that of the third red by copper, that of the fourth green, and that of the last blue. All ceased to be visible at a distance of sixteen hundred metres. The color of the red of gold was with difficulty distinguishable at fifteen hundred metres, while that of the red light colored by copper was still well defined. The green

* Illumination and Beaconage of the Coasts of France.

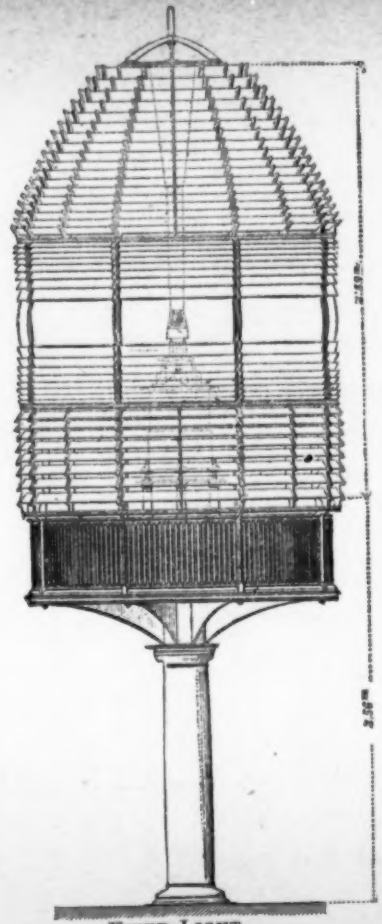
light disappeared at one thousand, and the blue light at five hundred and thirty metres." This is a very extraordinary result, it being remembered that possibly quite eight-tenths of the original light being obstructed by the colored medium, the remaining two-tenths, wholly red, carried as far as the unobstructed white light of five times the intensity. It shows that the primal intensity is not always a surety of farthest range, but that of two given lights the one having the greatest quantity of red rays is best. The light-house board has several times asked for an appropriation to make the necessary experiments on a large scale with an electric light, but have heretofore been refused. It is intended, if the request for the fifty thousand dollars needed is granted by the coming congress, to establish an electric light in one of the towers of the Highlands of Navesink lighthouse, where, the two lights of this station being two hundred and twenty-eight feet apart, an excellent base is afforded for comparative experiment; the Sandy Hook lighthouses and the two light-ships off Sandy Hook will afford excellent stations where the observations of intensity and visibility can be made.

The lenticular apparatus known as Fresnel has almost completely superseded the reflector or catoptric system in use before 1852. Six sizes are in general use, designated orders; and as for many years the French were the only makers, the result is uniformity throughout the world for any given order. The great expense of the plant and the great difficulty in obtaining workmen equal to the work have left the manufacture largely in the original hands: and the French firms of Lepaute, Barbier & Fenestre, and Sautter & Co., have almost the monopoly. The great glass firm of Chance Bros., of Birmingham, England, are their sole competitors. (See plates II and III.) The cost for a first order lens varied with flashes is about twelve thousand dollars, this being the most expensive apparatus furnished; the price diminishes rapidly with the size, being for a fixed light of the third order about two thousand, and for a fixed light of the fifth four hundred. Any special means of distinguishing a light by flashes, etc., increases of course the cost largely. On a coast so thickly lighted as our own, the question of distinguishing a light beyond mistake is a most important one, the means being fewer than may be supposed. The colors that may be used are practically reduced to white and red, these being the only ones used in our service, though green is sometimes used for short ranges in other countries. Even red is used in our sea-coast lights

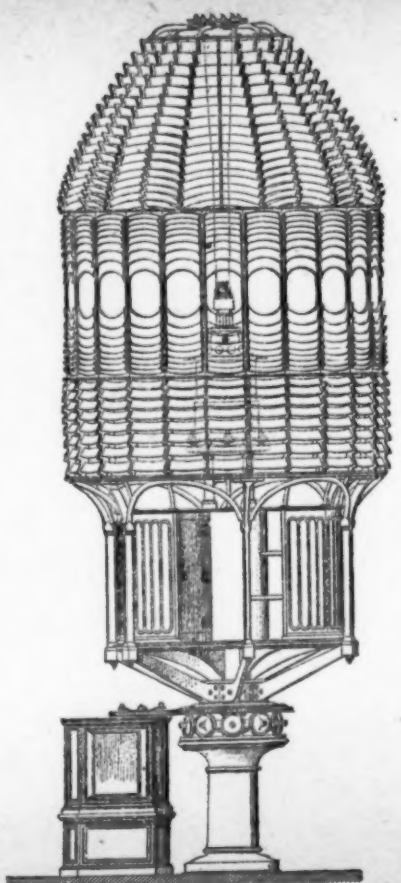
Plate II.



Lens for Flashing Light.

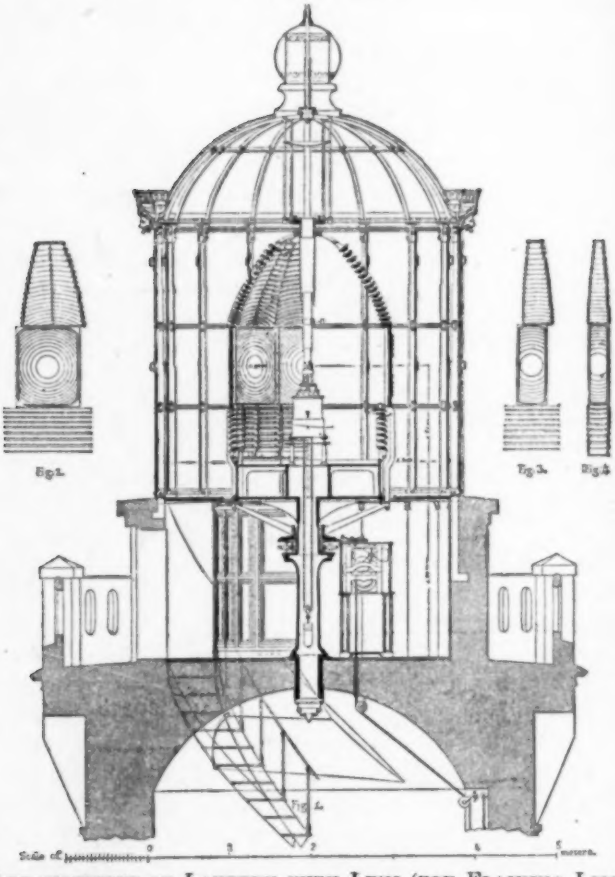


Fixed Light.



Quick Flash or Scintillating Light.

Plate III.



ARRANGEMENT OF LANTERN WITH LENS (FOR FLASHING LIGHT.)

to but a very limited extent, there being but three first order lights where it appears, and this in flashes, where the great increase of intensity by concentrating the beams of light in the flash causes any disparity to disappear. The lighthouse establishment has thus fixed upon the following distinguishing characteristics:

Fixed white; fixed red; flashing white; flashing red; flashing red and white; fixed white varied by white flashes; fixed white varied by red flashes; fixed white varied by red and white flashes; fixed red varied by red flashes; finally, two lights, and in one case three, near together. The name revolving light is discontinued. In the catoptric system there were a number of lamps and reflectors set in a frame which, if the light was fixed, was circular. In the case of the revolving light the frame was made square or triangular, and there was a group of lamps to each face, the number varying with the order. The flash which is substituted for the alternate illumination and obscuration produced by revolving the light itself, is now produced in lenticular apparatus in three ways; first, by sets of prisms with vertical elements which revolve about the central lens; secondly, by inserting in the drum of the fixed light apparatus, annular lenses and revolving the whole lens (these are used for a fixed light varied by flashes); third, by having the whole lens made up of a series of annular lenses, giving in its revolution a series of obscurations and flashes.

In a first order light, the original light of four hundred candle power is increased by the fixed lens (using the determination of the French lighthouse authorities) to ten thousand candles, and the flash prisms multiply the original intensity in some cases as much as three hundred and thirty times, producing thus a flash with an intensity of one hundred and thirty-two thousand. Color is given in lights which show only the one color, by a colored chimney; in cases of white lights varied by colored flashes, a colored panel is made to revolve about the exterior of the lens in connection with the flash panels. This interesting subject of the construction of lenses is fully discussed by Stevenson in his "Lighthouse Illumination," in which are given the formulas for the determination of the radii, etc., of the generating arcs, and I would refer any one interested in the subject to this book.

The general principle adopted by the board on its organization was that sea-coast lights of the first order should be placed at such intervals along the whole extent of the coast, that as a rule one light should not be lost sight of until another is made. We thus have the

great lights of Gay head, Block island, Montauk, Shinnecock, Fire island, etc., with a continuous intersection of lights of this class as far as cape Hatteras. East of Gay head the first order lights are not so numerous, there being, however, a continuous intersection of lights of a lower order. South of Hatteras the circumstances of the coast-line are not such as to demand the multiplicity of lights which is required further north: St. Augustine, cape Canaveral, Jupiter inlet and Fowey Rocks lights, on the eastern coast of Florida, being placed at intervals of about ninety miles; but in the next one hundred and eighty miles, in rounding the Florida Keys, there are found no less than seven lights of the first order. The extension of lights on the Pacific coast has followed the necessities of the case in the same manner. Most of the great headlands are lighted, and lights are multiplied wherever the needs of commerce demand it. Here, however, as on the eastern coast of Florida, the long stretches of coast-line without a break in which is a harbor or port, render such intervals as eighty or ninety miles between coast-lights not uncommon. It is the intention, however, to increase the number of lights on this coast as soon as the appropriations can be obtained.

It will thus be seen that our coast may be regarded as perfectly lighted; there being no part of it which is frequented on which the navigator in approaching it can find himself out of sight of a light-house. The difficulty has been to avoid too great a multiplication of lights due to local necessities, such lights being aids to those constantly using these points, but confusing to the general navigator less accustomed to them. There are in sight from one point in Nantucket sound fifteen, and from a point in Long Island sound thirteen light-houses and light-vessels.

The almost entire reconstruction of the stations built before 1852, and the addition of the great number since, have involved some of the most difficult examples of lighthouse engineering known. The simple plan of having four classes of towers, sixty-five, fifty, forty and thirty feet high, was soon discarded, and the lighthouse was suited to its locality. Minot's ledge lighthouse, built of granite to replace a pile structure erected in 1848 and destroyed in a gale of 1851, was completed in 1860 at a cost, including the keepers' houses ashore, of $300,000, and offers one of the best examples of modern lighthouse engineering, there being none which offered greater difficulties. Spectacle Reef lighthouse, built on a reef in lake Huron ten and a half miles from shore, is also of granite, and was completed in 1874 at a cost of

$375,000. Fowey Rocks lighthouse, a first order light on the coast of Florida, may be cited as an example of the iron-pile system of lighthouse, an application of which has been extensively made on our southern coast. Many of our large towers are of brick, as Shinnecock, Fire island, and others farther south. Iron has also been extensively employed, especially in lighthouses of the smaller class; but there are several of the largest class of this material, conspicuous amongst which is that newly built at cape Henry, with a height of one hundred and sixty-five feet.

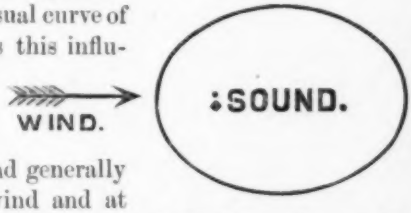
Though one would think that we had nearly perfected our system of lights, especially on the coast from New York eastward, there is still a constant addition to the number, and there are at the present moment three building in the Third district alone, and also two others which have just been completed and lighted.

The light-vessels are from 200 to 400 tons, differing in size according to the varying conditions in which they are placed. They are still using the reflector light, the lamp being a constant level lamp using mineral oil. There are no light-vessels in this country with other than fixed lights, though their use is not unusual in England and in northern Europe. There are eight lamps and reflectors in each lantern, there being two lanterns in use generally to each vessel, though occasionally there is but one. The crew consists of a keeper and an assistant, with from four to six men, one of whom is a cook. In case of being fitted with steam fog signal apparatus, two engineers are added to the complement. They are supplied with rations by the establishment, and the men receive the pay of $25 per month. Much difficulty is experienced in securely mooring those vessels exposed to the full sweep of the sea; a position in which most of them are, the most distant from shore being that on New South shoals, 27 miles from Nantucket. Mushroom anchors of from 3600 to 4800 lbs. are used, usually backed by a smaller one. They are generally moored with forty-five fathoms of chain on each leg of the bridle, and ride to a scope of chain accommodated to the weather. The greatest care, however, will not always insure their permanency, and scarcely a winter passes without the breaking adrift of one or more, several days sometimes passing before their recovery. Being schooner-rigged, the masts for the sails being fitted abaft the lantern masts, they have usually shown that they are able to take care of themselves when driven to sea, and have generally found their way to port without assistance.

Of equal importance with the lighting of the coast are the buoyage and fog signals; indeed, this last, in a climate such as ours, where fogs prevail to such a great degree, may be considered of primal importance, taking rank as a necessity almost before the lights themselves. In the efforts to perfect the systems of signalling in fogs, the lighthouse establishment of the United States stands pre-eminent, more having been done in this country to further this object than in any other. In respect to this we occupy the position which the French establishment has held in relation to lights. The means now employed are bells rung by clockwork, bell-buoys, hot-air trumpets, steam sirens, steam whistles and automatic whistling buoys; all these are of comparatively very late adoption, the bells rung by clockwork coming first. Daboll's trumpet, worked by blasts of air, was adopted in 1855, and is widely used, especially at stations where it is difficult to get a good water supply. The air used for the blasts was formerly compressed by horse power, but hot-air engines of the Ericsson type are now used generally. This trumpet, which in one of the first class has a length of seventeen feet, and a steel reed ten inches long, two and three-quarters wide and an inch thick at the fixed end, was, until the introduction of the steam siren, the most powerful fog-signal known. The latter, however, has superseded it where an intense and far-reaching sound is specially desirable, and where the water supply will admit of its use. It is worked with a steam pressure of from fifty to sixty pounds, a locomotive boiler being generally used for the purpose; the whole of the machinery, as in the case also of the Daboll trumpet, being in duplicate, in case of accident to that in use. The ordinary steam whistle is also largely used, and by some experts is preferred to any other means of signalling in fog. The whole subject of fog signals is an extremely intricate one, and the laws governing their audibility as yet very imperfectly known. The vagaries of sound are beyond the belief of one who has not experimented in the subject, and the most opposite opinions of the laws governing the action of sound have been held by such authorities as Professors Henry and Tyndall. There can be but one absolute rule formulated for the navigator's guidance, and that is, that he must not expect *surely* to hear a fog signal, no matter how near he may be to it. A signal has been inaudible at one time at a distance of half a mile, which at other times has been heard in the same direction fourteen. There may also be intervals of inaudibility, the sound skipping a space of one or more miles and reappearing at a much farther point in the same direction. I have seen

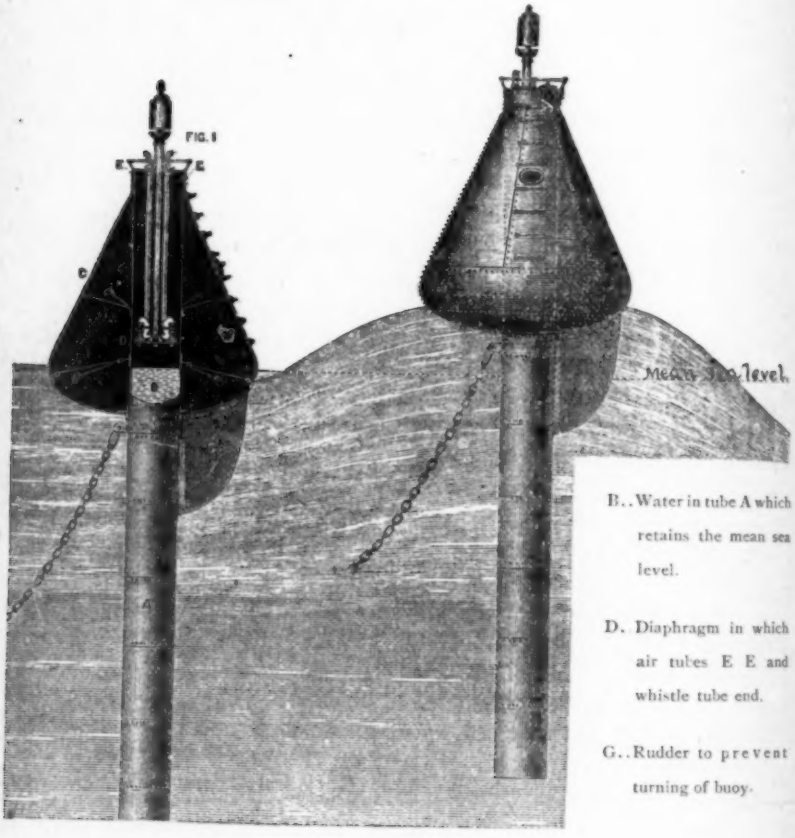
at a distance of half a mile the steam rising from the mouth of the steam siren, which I knew to be working with a steam pressure of fifty-six pounds, and not a murmur of a sound be heard.

Very extensive experiments have been carried on by the lighthouse board in this country, and by Professor Tyndall at the instance of the Trinity board in England. Prof. Tyndall ascribes the inaudibility chiefly to a flocculence or non-homogeneity of the atmosphere. Prof. Henry lays greater stress upon the direction of the wind. It certainly appears that the sound is *generally* heard better down the wind than against it, the accompanying figure representing what may be taken as the usual curve of audibility. Why the wind has this influence has not yet been explained in any satisfactory way. I think, however, that experiment leaves no doubt that sound generally can be heard better down the wind and at right angles to its direction than against it. I use the word generally advisedly, as there are remarkable instances of the reverse of this. In spite of the usual impression, an impression which held even amongst the best informed until lately, fog and snow have of themselves no important influence upon the transmission of sound. *Under no other circumstances is sound so transmissible on our coast as in a northeast snow storm.* Signals rarely audible at much shorter distances are then heard frequently from seventeen to nineteen miles *dead to windward*, and it seems that they are then heard better to windward than to leeward, though upon this last point the evidence is not clear. The only reason that has been assigned for this extreme transmissibility is that the atmosphere must be rendered perfectly homogeneous by the particles of falling snow. Calms or light airs are treacherous; be not deceived by the stillness of the atmosphere or the smoothness of the sea, which seem to render it impossible that the signal could not be heard if working; it is at this very time that its audibility is least certain; and in the driving snow storm, when it would seem to one that it would be most obstructed, it sounds with the greatest clearness and with the least uncertainty.



No more important addition has been made in late years to aids to navigation than the whistling buoy, invented by Mr. J. M. Courtenay, formerly of the East India Company's service, but for many years a citizen of the United States. (See plate IV.) The idea underlying the

Plate IV.



B..Water in tube A which retains the mean sea level.

D. Diaphragm in which air tubes E E and whistle tube end.

G..Rudder to prevent turning of buoy.

invention first came to him by observing that the water in the interior of a steamer's smoke-pipe which was being hoisted on board at the cape of Good Hope, remained at a comparatively constant level whatever the motion of the sea about the exterior. Thus when the buoy rises with the sea there is a large air space in the cylinder to be filled with air from without; when the buoy begins to fall, the valve attached to the tube permitting the ingress of air is closed, and the air is forced out through the whistle, which is an ordinary one, such as is used for steam whistles. The whole is of extreme simplicity, with very little liability to get out of order; the chief trouble arising from the bending of the whistle by being struck by vessels. Very often too, strange to say, the whistles are used as targets by passers-by, and marks of bullets are frequently found upon them, a marked proof of a widely distributed want of moral sense, as nothing could be more purposeless or could be more fraught with danger to the navigator. These buoys have been widely adopted elsewhere throughout the world: they answer their purpose admirably, are a good day mark, and an excellent guide in fog, their sound having been heard under favorable circumstances over fifteen miles. The sea is rarely so motionless that their sound may not be heard at a considerable distance.

Endeavors have also been made to show an electric light on buoys which were to work a dynamic machine on the same principle that the whistling buoy does its work; the only experiment that has been made, however, has thus far been a failure. The Pintsch buoy, which contains a reservoir of gas made from fat, has been more successful. The buoy is charged with gas at a pressure of six atmospheres, and will burn continuously, according to its size, from thirty to one hundred and twenty days. It is provided with a regulator, which is a necessity for giving a flame constant in size, and is fitted with a small lenticular apparatus. One was placed by the company as an experiment near the Wreck of Scotland light-vessel during the past summer, and seemed to work well. Several are in use by the Trinity board of England.

The buoys just spoken of are light and sound signals, rather than day marks. Of these last we have over three thousand, marking almost every hidden rock and danger in navigable waters along our coast. Every wooden buoy is changed yearly, and every iron buoy twice a year; this involves an immense labor on the part of the tenders, and is one of the most important parts of the duty which they perform. The buoys when taken up are scraped, dried and repainted, ready for relaying. The greater number, of course, are wooden spars,

differing in length according to the water in which they are placed, some having a length of sixty feet. The use of these in southern waters is discontinued on account of the destruction by worms, and they are there entirely replaced by iron buoys, which are also used in northern waters to mark the more important points. There are three classes of these, the first having a diameter of six feet and a height of nine feet six inches; the second, four feet four inches by seven feet; the third, three feet two inches by four feet ten inches high. The cost of a first class buoy with its appurtenances is about five hundred dollars. In placing the can or nun buoys, there is a large iron ball, weighing eleven hundred and fifty, four hundred and seventy, and ninety-five pounds, according to class, attached to keep them upright. The first class are usually moored with seven and a half fathoms of one and a half inch chain and a stone sinker of four thousand pounds. These sinkers afford the best and cheapest moorings for buoys that can be used; there is a hole drilled through them through which is run an iron bar with an eye in one end, the bar is simply bent on the under side, and the mooring is ready for use, costing but about nine dollars complete. The life of a chain cannot be reckoned at more than eighteen months or two years; the attrition on those links suspended near the bottom is greatest, the parts on the bottom itself and near the buoy being comparatively little injured, excepting by the natural rust which takes place. Wooden spar buoys are much damaged, frequently by steamers; a fortnight rarely passing in the Third district, for instance, without the necessity of relaying a buoy which is broken short off by a paddle wheel or cut by a screw. The iron buoys are steadfast, excepting in moving ice; during the last winter, buoys to the value, with their appendages, of ten thousand dollars were carried to sea from New York harbor and bay, very few of which were ever recovered. One found its way to Turk's island, one was brought into Madeira by a vessel which picked it up not many miles from the island, and others were sighted at various points and reported. Some years since one drifted into Cork harbor, which was presented to the Irish lighthouse board, and is now moored on the Irish coast. Of course the direction of their travels is not wholly due to the currents, as they expose a very considerable surface to the wind. Some experiments have been made with spar shaped buoys, made of iron, and it may be practicable to make a buoy of this material and shape, larger than the ordinary spar, which will resist the ice. It was not until 1850 that congress established by law a syste-

matic method of painting and numbering buoys; red buoys thus mark the starboard side of the channel coming from seaward, and black the port; dangers and obstructions having a channel on either hand are marked with black and red horizontal stripes; and mid-channel buoys, to be passed close to, are marked with vertical black and white stripes. The buoys are numbered from the seaward end of the channel, the black bearing the odd and the red the even numbers. If there is a branching channel, as say the Passaic river, which with the Kill von Kull enters New York bay on the north side of Staten island, the numbers begin anew at the mouth of this channel. All buoys marking prominent points are marked with the name.

The *personnel* required to carry on the service of all the foregoing is of course very large. To each district there are generally attached two steamers for the inspector's and engineer's work, which carry supplies, attend to the buoyage, and are used in making the inspections. There is now a total of twenty-three steamers and three schooners in the service; to each of the steamers there are ordinarily a master and mate, two engineers, two firemen, a crew of six others, and a cook and steward. The number of keepers at a light varies in number with its importance and position, from one to three and sometimes four. There are one thousand one hundred and forty keepers, besides those on the Mississippi, Missouri, and Ohio, who cannot number less than five hundred. The salaries of these keepers vary from one thousand dollars to one hundred; the greater number being between four hundred and six hundred. The smallest pay is given to the keepers of stake lights and lighted beacons, which only require such time in attending them as can be easily given by a man who keeps up his ordinary occupation. The keepers of all lighthouses are well lodged; have boats where the situation renders boating necessary, and are supplied with libraries, which are contained in neat cases, holding about forty volumes, which are exchanged from time to time as desired by the keeper. Keepers may, upon a vacancy occurring, be promoted from one station to another, and it is the aim to make their positions tenable during good behavior. The final vacancy, which occurs after all changes or promotions have been made which may occur from a death or resignation, is filled by nomination by the collector of the district in which this final vacancy occurs. The nominee receives an acting appointment, which is changed to a full appointment after an examination and a report by the inspector that he is efficient.

The estimates of the lighthouse board for the coming year amount to about 2,700,000 dollars; the increase being chiefly due to the pro-

posed building of some new first order lights on the Pacific coast. The expenditure of this sum, which is made with the utmost economy and care, is an absolute necessity for a proper lighting of the coast and guarding navigation; the lighthouse board, instead of seeking to increase its expenditures, has ever since its establishment acted with the utmost conservatism, has resisted the building of lighthouses, unless in its judgment such a light was necessary. The best means known for lighting, for signalling in fogs, and for marking shoals and channels, are employed of course in every case irrespective of expense, as this is only what is demanded by humanity, but the expenditure has not more than kept pace with the vast traffic which it aids. Our government from the outset has made this expenditure to be borne by the national treasury, nothing being exacted from any vessel of any nationality in return for the benefit given, excepting for a short interval dating from 1804, during which a light duty of fifty cents a ton was levied on foreign shipping. This principle was far in advance of that held by most European powers until within a few years, and even now the entire expenses of the lights of Great Britain and Ireland are borne by the shipping using their ports.

The following table shows the comparative cost of our establishment from the beginning:

Year.	No. of lights and light-vessels.	Cost of support (buoyage, &c., included).
1791	10	$ 22,000
1805	28	93,451
1820	55	244,000
1835	201	382,000
1850	345	633,401
1860	472	729,386
1870	561	1,447,007

The board's estimates for 1880 were for:

Salaries of keepers of lighthouses	$ 585,000
Expenses of light-vessels	250,000
Expenses of buoyage	325,000
Expenses of fog signals	60,000
Inspecting lights	4,000
Supplies of lighthouses	375,000
Repairs of lighthouses	400,000
Lighting and buoyage of Mississippi, Missouri and Ohio rivers	150,000
Amount carried forward	$2,149,000

Amount brought forward	$2,149,000
Expenses of day beacons	25,000
Survey of lighthouse sites	10,000
Fog signals on light-ships	15,000
Steam tender for Atlantic coast (new)	55,000
For building four new light-stations	169,000
For experiments with electric lights	50,000
For other purposes	2,925
Total	$2,475,925

The Lights of Great Britain and Ireland.

The lights of the United Kingdom are under an intricate and cumbersome management, the legacy of an antique system, which a too conservative spirit has prevented discarding in spite of the frequent endeavors of the last forty years.

The Trinity house, subject in some degree to the authority of the board of trade, has the general superintendence and management of all lighthouses, etc., in England, Wales, the Channel islands, Gibraltar and Heligoland, except those which are under local authority; which last, however, are also subject to its inspection.

The commissioners of the northern lighthouses, subject in some matters to the control of the Trinity house, and the ultimate control of the board of trade, control in Scotland and the Isle of Man.

The Ballast board of Dublin have similar authority in Ireland.

These general authorities may levy dues, or, with the consent of the Queen in council, may exempt from dues, alter mode of collection, or substitute other dues.

In all cases of altering, building or removing lights, or placing or removing beacons or buoys, the Scotch and Irish boards must have the consent of the Trinity board; any case in dispute is carried to the board of trade; they may also, with the sanction of the board of trade, compel local authorities (of which by the parliamentary report of 1861 there were about 170) to erect, change or discontinue lights or buoys. It will be seen that the above must be productive of much inconvenience, and, like all divided responsibility, must be injurious to its branch of the public service.

The first of these boards is one of the earliest corporations of England, existing as early as the reign of Henry VII, as an association for piloting ships. Its first charter was dated May 20, 1514, in the reign of Henry VIII, and with alterations under successive

sovereigns, was established as it is to-day by James I. The corporation is designated in its charter as "The Master, Wardens and Assistants of the Guild, Fraternity or Brotherhood of the most Glorious and Undivided Trinity, and of St. Clement in the Parish of Deptford Strond in the County of Kent." There are twenty-nine Elder Brethren, including two officers of the navy, and thirteen honorary members, who are elected as vacancies occur from members of the nobility; the remainder are retired officers of the merchant service. There is a body termed the Junior Brethren, who have no duties and whose number is not limited, who are elected by the elder brethren, and from whom the elder brethren are recruited as vacancies occur. Each active member of the elder brethren receives £350 a year from the revenues. The deputy master, the mastership which is a sinecure being held by one of the honorary members, is the executive officer, and is elected from the active list of the elder brethren.

It was not until 1565 that the corporation by act of parliament was empowered "to preserve ancient sea-marks, and to erect beacons, marks and signs of the sea." Under this act, Trinity house, in the reign of James I, claimed exclusive control over all lighthouses. The privy council in 1617 admitted their claim under the advice of Sir Francis Bacon, then attorney general; but a subsequent council, through pressure from the king, upheld by Bacon, who had changed his mind, gave the crown power to grant patents to other persons, and the king sold speculative permissions to do so, professedly whenever the Trinity board failed to meet the wants of mariners.*

That the Trinity house was somewhat slow to take advantage of the privileges granted in the charter of 1565 may be judged from the fact that no lighthouse was erected by the corporation until 1680. From thenceforward it received numerous patents for the erection of lights and collection of tolls in the same manner as such were granted to individuals. Copies of several such patents may be found in the reports of the parliamentary boards on British lighthouses of 1834 and 1845.

The board of commissioners for northern lighthouses was established in 1798 by act of parliament for the management of lights and buoys in Scotland; Trinity house having previously held in Scotland after the union, the same privileges as in England. The commissioners are unpaid and hold their positions *ex-officio*. "They consist of two law officers of the crown, the sheriffs of certain maritime counties, the

* British Almanac and Companion, 1873.

provosts of certain royal burghs, and the provost of Greenock." They are, in the words of an English writer on the subject, almost without exception merchants or lawyers. None of these gentlemen can be supposed, excepting in casual cases, to know anything of the subject; but the disadvantage arising from the constitution of the board has been counteracted in a great measure by the employment as their engineers of very able men; the Stephensons for three generations being the chief power in the corporation. The northern lighthouses thus were for many years far in advance of those of England and Ireland. They were the first to adopt improvements, and have given to the world some of its finest examples of lighthouse architecture and engineering. Taken altogether, the Scotch lighthouse board may be said to have shown remarkable excellence and efficiency, due, however, to the wisdom which subordinated the inexperience of the individual members to the skill and knowledge of the able men they employed as their executive officers, the Stephensons just mentioned.

The Ballast board of Dublin was incorporated in 1786, and in 1810 the control of the Irish lighthouses was given to it. There are about twenty members, few having any acquaintance with nautical or scientific matters; the lord mayor and high sheriff of Dublin are members *ex-officio*; three of the aldermen of Dublin are also members, and the remainder are members of the chamber of commerce, directors of railways, &c. The inspector of the lights under them is an officer of the royal navy.

It was not until 1836 that the entire control of the coast lighthouses of England and Wales was vested by law in the Trinity corporation; harbor and other local lights being still maintained by local corporations. Under the act of this date the interest of the ten coast lighthouses which still remained in private hands, was bought by the board for the great sum of £1,182,546. The Smalls, Spurn, and Skerries brought respectively £170,468, £309,531, and £454,984, the net revenue of the last named having been in 1840 £20,042. When it is understood that sometimes as much as twenty per cent. was allowed for the collection of these revenues, it will be seen what an enormous and unjust tax this was upon commerce. Prior to 1836 the tax was from one-sixth of a penny to a penny a ton upon all ships at each time of passing a light; but later, a uniform rate of half a penny a ton, with some few exceptions, was established; national vessels, fishing vessels, and vessels in ballast being exempt.

These dues are collected by the officers of customs, and constitute a lien upon the vessel or her equipment; they are now paid into "the

mercantile marine fund," which is recruited by fees received by the board of trade under the merchant shipping act, arising from granting of certificates, registration, &c.; by light-dues received by the Trinity house, the commissioners of northern lighthouses, or the port of Dublin corporation; by all money received by the Trinity house for lastage and ballastage in the river Thames, and by all money accruing to government in cases relating to wrecks or salvage.

"Each of the general lighthouse authorities has the power," in the words of the act, "with the consent of her Majesty in council, to do any of the following things:

"To exempt any ships or any classes of ships, from the payment of light-dues receivable by such authority.

"To alter the times, places and modes at and in which the light-dues receivable by such authority are payable.

"To substitute any other dues or class of dues, whether by way of annual payment or otherwise . . . for the dues payable to such authority for the time being."

"Tables of all light-dues and a copy of the regulations for the time being in force, shall be posted up at all the custom-houses in the United Kingdom."

It will thus be seen that the dues may vary from year to year, but a general idea of the expense to shipping may be gathered from the fact that the line of American steamers from Philadelphia to Liverpool pays about $250 per voyage to the English and Irish lights. A vessel of 1431 tons from New York to Liverpool in 1877 paid £16 2s 3d; one of 533 tons from New York to Belfast, £8 18s 6d; one of 1316 tons from New York to London paid £28 8s 4d. In earlier days these dues were much greater; a case being cited on the floor of the house of representatives in 1804, of a ship of 284 tons from New York to London paying £34 light dues.

Several efforts have been made to bring about a juster policy on the part of the British government by our own, but the fact that direct taxation would be increased by the amount necessary to support the lighthouse system has been the real hindrance. The United States has uniformly protested against taxes of this kind imposed on shipping, and was the first to make an effort to abolish the Sound dues collected by Denmark, the proposition to pay the capital value of the annual collections being made on the basis that these were made for the support of aids to navigation, the United States refusing to recognize the right of Denmark to tax vessels simply for the use of these waters as a highway. Great Britain paid more than a million

sterling, or more than half the entire amount; the United States paid $393,011, and in a convention concluded in Washington, April 11, 1857, the entire freedom of the Sound and Belts was guaranteed to American vessels, and that no dues should be charged for lights or buoys maintained by Denmark.

Similar dues had been levied by Hanover on shipping using the Elbe. These were extinguished in 1862 by the payment on the part of the United States of $36,000; other commercial nations paying in proportion to their commerce on the river. In 1864 we agreed to pay, in ten annual payments, the sum of $550,000 as our share in the liberation of the navigation of the Scheldt from the tonnage dues previously charged.*

We thus see that England has not been alone in the enforcement of such a tax, though I doubt if all would ever be willing to assist in the capitalization of the British lighthouse dues, as in those just before noted. It would require an aggregate of over £10,000,000 sterling to yield an interest at four per cent. equal to the present annual dues. This should be done by Great Britain herself. Our own system of absolute freedom from direct charges of any kind upon shipping, the expense of maintenance of lights, &c., being borne by the public treasury, seems the only really enlightened and fair policy.

The total revenue of the British lights under the three public corporations, for the year ending March 31, 1878, was £408,521, divided as follows: Trinity house, £323,476; Irish board, £31,022; Northern, £54,022; about seventy per cent. of this sum was paid by British shipping. The expenditures for the same year were as follows:

	Trinity House.	Irish Board.	Northern Board.
Maintenance of lighthouses	£29,649	£30,477	£25,544
Maintenance of light-vessels	46,351	15,978	....
Maintenance of buoys and beacons	8,905	2,394	1,584
Maintenance of steam and sailing vessels	49,781	13,570	11,125
Salaries of the establishment	19,006	3,992	3,029
Office and house expenses	6,393	2,749	1,034
Miscellaneous expenses	3,066	2,519	2,091
Charges for collection	5,224	1,345	519
Superannuations of officers and clerks	8,541	2,086	2,802
Stores, labor and materials	34,160	....	....
New works	34,143	11,806	4,962
	245,224	86,917	52,695
Or a total of	£384,836		

* Penn Monthly, July, 1873.

This forms much the largest charge upon the mercantile marine fund, the total of whose dues in the same year was £534,667.

In later years the British lighthouse boards have been among the foremost in the advances made in lighthouse illumination, Faraday and Tyndall both having given their services to the Trinity corporation. Several electric lights are in operation on the English coast, and much attention has been given by the Irish board to gas as an illuminant, with great success; gas is used in many cases also in England and Scotland. The buoyage of the coasts of the United Kingdom has, however, offered a better opportunity for the display of originality and diversity than have the lights. The report of the parliamentary committee of 1861 says, "Until lately there has been no attempt at uniformity in any part of the British isles, but the northern commissioners adopted a system, the main feature of which is placing red buoys on the starboard hand on entering a harbor and black on the port hand. The Irish board have frequently adopted a system too, but it is exactly the reverse of the Scotch; and only last year the Trinity house decided to buoy channels uniformly, but on a totally different plan, namely, red and black buoys to starboard and checkered to port, but they do not contemplate applying it to channels already buoyed. . . . In the meantime some of the local authorities, as those at Liverpool and the Clyde, have adopted systems of their own, which may or may not be the same as that of the general authority in the same country."

The system adopted by Trinity house has been, I believe, generally extended, and is to place red or black can buoys on the starboard hand on entering, and buoys of the same color either checkered black and white, or red and white, or marked in vertical stripes of these colors, on the port hand. Turning points are marked by nun buoys, and middle grounds by buoys with horizontal stripes, black and white or red and white, according to the color in use in that channel; wrecks are distinguished by a green buoy. The spar buoy in such general use in this country is not used in the United Kingdom, though as a day mark it is as a rule more easily seen than the can or nun. The latter, however, are much more easily distinguishable at night.

The fog signals in use do not differ materially from our own, the Daboll trumpet and the siren both being largely used, excepting that guns are sometimes used, which are fired at fixed intervals, and a rocket fog signal has been adopted, which is discharged at fixed intervals and explodes at an elevation of about four hundred feet. There

is no doubt of the value of such signals as this last, as in addition to the noise of the explosion there is the general illumination of the fog or glare from the light, especially marked in cases of red colored flame. The intervals of the sounding of the English fog trumpets appear much longer than it has been thought advisable to make them in this country; that at Bardsey island being sounded but once in five minutes, and three is a frequent interval.

Some of the English light-vessels are fitted with revolving lights; the use of these being not uncommon also on the coasts of continental Europe in general. In other respects they are not unlike our own. Among the regulations governing them, which are not in use in this country, are to be noted that a white light is exhibited from the fore-stay of the vessel for the purpose of showing in which direction she is riding.

When driven from position, a fixed red light is exhibited at each end of the vessel and a red flare shown every quarter of an hour.

When a vessel is seen standing into danger, a gun is to be fired until observed by the vessel; also the signal flags of the commercial code, signifying "you are standing into danger," are to be hoisted and kept flying until answered.

The use of colored sectors to distinguish shoals, etc., is much used in the English lights; the first order light of Usk, for instance, showing white from NE b E¾E to NNE, red from NNE to N b W ¼W, white from thence to NNW½W, red from thence to the land. Between W b S¼S and SW b W¼W it shows green.

Their system regarding keepers is, however, much in advance of our own. The Trinity regulations require that applicants shall be between nineteen and twenty-eight years of age, of good character and physique, and having a common English education. There are always eight candidates under instruction at Blackwall and two at the South Foreland light, the latter learning the management of the electric light at that station. As vacancies occur they are filled from these men. Four classes of certificates are given: The first for competency in light-keeper's duties; the second for competency in the use of tools and the management of the steam engine; the third includes instruction in the management and care of the electric light, and the fourth the management of fog signals. When no longer able to do service, keepers are pensioned. Of course an elaborate system, such as the above, cannot be hoped for here until permanency of position is assured the keeper during good behavior.

Other Lighthouse Establishments.

The lights of France, previous to 1792, belonged, with few exceptions, to local corporations; in that year their charge was assigned to the ministry of marine, but the execution of the works was in the hands of the ministry of the interior. In 1806 they were placed under the administration of roads and bridges, and in 1811 the lighthouse commission was organized, "composed in the beginning of three naval officers, three members of the Institute, and three inspectors-general of roads and bridges." The following actual membership gives an idea of its present composition: the minister of public works, who is *ex-officio* president; a retired rear-admiral, member of the bureau of longitude; a rear-admiral on the active list; a captain in the navy; an inspector-general of roads and bridges and naval works; an inspector-general of marine engineering; a retired inspector-general of roads and bridges; the hydrographer-in-chief to the admiralty; a civil member of the bureau of longitude; a member of the academy of sciences, and finally another inspector-general of roads and bridges, director of the service of lights and buoys, who was secretary to the commission.

There is of course at the present time no differences between the French system of lights and those of our own or Great Britain. The entire organization seems to be one of high efficiency, and takes rank among the first as to beauty and excellence of buildings, completeness of apparatus, and character of *personnel*. The keepers, as those of England, hold permanent positions and are uniformed.

The buoyage differs but little from our own: all the buoys left on the starboard hand coming in from sea are colored red, with a white band immediately below the top. Those on the port hand are black; those which may be left on either hand are painted in red and black horizontal bands. The colors may be uniform over the buoy, or divided up to form various designs on a white ground, such as checkers, horizontal bands or vertical stripes, in case of unusual necessity for distinction. Upon each buoy is painted the name of the place marked, and each, excepting those horizontally striped, has its number, the system of numbering being the same as our own.

The administration of the lighthouse system of Spain is similar to that of France. In Holland the management is under the minister of marine.

In Belgium, the construction is under the minister of public works, but the lighthouses when completed are handed over to the direction of the navy, and the expenses are estimated in the naval budget. The buoy system of these last two countries is the same; white buoys being left on the starboard hand in entering from sea, and black on the port; red buoys are placed at the separation of two channels.

The lighthouse establishments of Austria, Denmark, and Russia, and the German Empire, are all under the ministry of marine. Each nationality has its separate system of buoyage. It is much to be regretted that there could not be devised an international system of buoyage common to the world, which would obviate the many chances of mistakes and misunderstandings which must now occur.

The following table gives the coast and harbor lights of the world in 1879:

British America	416	Portugal	19
United States	708	Italy and adjacent islands	219
West Indies	121	Malta	6
South America	83	Austria	107
Pacific Islands	10	Turkey	88
China	33	Greece	51
Japan	52	Russia	129
Australia	110	North Germany	113
Tasmania, New Caledonia, and New Zealand	46	Denmark, Norway and Sweden	318
Siam	1	Egypt	11
Cochin China	3	Syria	19
England, Scotland and Ireland	633	North Africa	53
Belgium	24	West and south coast of Africa	53
Holland	143	South and east coast of Africa and islands	26
France	353	India	165
Spain, Canary Isl. and Morocco	203		
Total	4416		

This great number speaks well for the world's humanity, and is a wonderful advance over the meager showing of eighty, or even fifty years since; an advance, too, more marked in quality even than in numbers.

NOTE.—The following were used in the preparation of this paper, viz: Documents relating to lighthouses; Laws relating to lighthouses, 1789–1855; Annual reports of the U. S. lighthouse board; Illumination and Beaconage of the Coasts of France, (Reynaud, inspector general of bridges and roads, and director of the

light and buoy service, translated and published under the direction of the lighthouse board); Reports of the British parliamentary commissioners on lighthouses of 1834 and 1846; Extracts from British lighthouse reports (which embody the report of the commission of 1861); The merchant-shipping acts of Great Britain; Stephenson on lighthouse illumination, &c.; Appleton's American Cyclopedia and Encyclopedia Britannica, (articles, lighthouses); Lighthouse establishment of the United States, by A. B. Johnson, chief clerk of the lighthouse board, republished from Appleton's Annual Cyclopedia, 1880; and Lighthouse lists of the world.

NAVAL INSTITUTE, ANNAPOLIS, MD.

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REAR-ADMIRAL C. R. P. RODGERS, U. S. N., in the Chair.

THE NAVAL CAMPAIGN OF 1812.

BY PROF. J. RUSSELL SOLEY, U. S. N.

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In order to understand fully the merits of the early actions of the war of 1812, it is necessary to notice for a moment the policy of the naval administration during the period preceding the war, and the condition of the navy when the war broke out. The navy of that day and of the present really dates from 1794, when an act of Congress provided for the building of six frigates, to check the depredations of Algerine corsairs.*

The old revolutionary navy had entirely passed out of existence; and though some of the senior officers of the new ships were selected from among the well-known revolutionary names, they were men who had been for ten years in private life, and their juniors had never before seen any naval service. Selected hastily, most of them in the course of a few months, the corps of officers was necessarily an ill-trained and unwieldy body; and Morris tells us in his autobiography how imperfect the selection was. Algiers gave the new navy nothing to do; but, fortunately for the service, the energetic action of the Congress of 1798, in declaring reprisals upon French armed vessels, gave it active and salutary occupation. By the autumn of 1798 nearly the whole fleet, composed of all the frigates that were ready, and many other vessels, numbering altogether about twenty, were cruising in the West Indies,

*Act approved March 27, 1794.

where they remained for two years. In 1801, the Peace Establishment Act, by reducing the number of officers in all grades, while it operated severely upon some of the veterans, nevertheless proved of substantial benefit in winnowing the service of most of the chaff that had entered in 1798. The officers who remained, and who formed the nucleus of the modern navy, comprised a large number of able men, most of them young men, who were animated by an intense *esprit de corps*, and ambition for the profession, and who developed later an extraordinary aptitude for it. All that they needed was training in active service, and a field for the exercise of their undeveloped powers. This came to them in the Tripolitan war, which occupied the navy for four years. It gave the junior officers the best possible training, under such able commanders as Dale, Rodgers, and Preble; and the eagerness with which they seized every opportunity for winning fame for the service shows the zest with which they had entered upon the profession.

The foreign policy of the administration during the next few years was one of peace and self-abnegation. The wars of Napoleon were then at their height, and the United States suffered the humiliations of a timid neutral between two unscrupulous belligerents. This timidity arose not so much from the weakness of the state as from the weakness of parties. The naval campaign against France in 1798 had been very successful, as were subsequently the naval campaigns against England in 1812; and a bold policy might have led to a like success in 1805. But, unfortunately, the rivalry of France and England was reflected at home. The federalists would not hear of a war with England, nor the anti-federalists of hostilities with France; and though the former were generally the advocates of a spirited foreign policy, yet their indignation was never very marked upon a question of English aggression,—and John Quincy Adams tells us that he abandoned his party because it resented the outrage on the Chesapeake in so lukewarm a fashion.

By way of retaliation for belligerent encroachments, Jefferson adopted the self-denying measure of the embargo, which forbade the departure of any ships from the ports of the United States, except foreign ships in ballast and coasters. As an offensive measure it was a failure, while its effect at home was most disastrous. As it soon became evident that it threatened the mercantile interests of the country with ruin, it was replaced by a prohibition on importation from France and Great Britain. This was so far better, in that under

it American vessels were free to go abroad and pursue such trade as they could. But it had one fatal result, which must have been foreseen at its passage. Fully nineteen-twentieths of the revenue of the state was derived from customs, and by the non-importation acts more than half the usual amount was withdrawn. The revenue fell from $17,000,000 in 1808 to $7,770,000 in 1809; and the government, while it was pursuing an aggressive foreign policy that might end in war, was voluntarily cutting off its own resources. The act was repealed in 1810, but the government, to save its self-respect, was given authority, in case either power revoked its noxious decrees and the other refused, to revive the prohibition against the offender.

When Congress met, late in 1811, a strong war-party of younger men obtained the control of affairs. Though both nations had committed aggressions, and though France was far less capable of effective hostilities, the old antipathy of the anti-federalist party for Great Britain directed the energies of the new movement chiefly against that power. For this there was some excuse, in that France had latterly made a show of concession, to which England, more candid and direct in her negotiations, had failed to respond. The relations with England were, moreover, complicated by the grievance of impressment. The dominant party carried everything before it, and on the 18th of June, 1812, war was declared against Great Britain.

During all this period, when a rupture often seemed imminent, little was done to improve the navy. The last vessels of any size that were added to it were the brig Hornet in 1805 (later altered to a sloop), and the sloop-of-war Wasp in 1806, rating 18 guns each. The remaining efforts of the naval administration were devoted to the building of gunboats.

Attention was first directed to this species of war-vessel by their success in the operations before Tripoli. For special services, such as that for which Preble employed them, as auxiliary to larger vessels, in flotilla-engagements in shoal waters, and for attacking the picaroons and other piratical craft that infested the West Indies, they were no doubt of some use. But Jefferson's idea—and it was peculiarly his idea—was to transform the navy into a fleet of gunboats, to do away with the frigates, and if the country became involved in war, to make it a defensive war solely. It was claimed for the gunboats that, together with fortifications, they would be the best protection for coasts and harbors, the mouths of rivers, and shoal waters in general. This scheme of defence was a part of the isolating policy of the gov-

ernment,—a policy which sought to draw the nation in upon itself, to surround it with barriers, to destroy intercourse and commerce with the rest of the world, and to repel attack by means of forts, embargoes, and prohibitions on importation.

During Jefferson's administration, Congress was ready to carry out the plan to its fullest extent. In 1806 and 1807 over a million of dollars were expended in the building of gunboats. The materials for six ships-of-the-line, which had been accumulated during Adams's administration, were devoted to the same object. One hundred and seventy-six gunboats were built, and distributed in the bays and harbors; and the ablest of the older lieutenants were placed in command of flotillas, to enforce the embargo at the different ports, and to suppress the commerce they were commissioned to protect.

In 1809, upon a change of Presidents, Congress made an examination of the working of the system, and it was found that the one hundred and seventy-six gunboats in the service had cost $1,800,000. The cost of the frigate President, mounting 56 guns, armament and all, was $220,000. Hence the money that was wasted on the gunboats would have built eight first-class frigates; frigates which the British authorities always asserted were equal to small line-of-battle-ships. It was also found that the annual cost of a frigate carrying 56 guns was $120,000, while that of fifty-six gunboats carrying one gun each was $650,000.

These figures put an end to the gunboat system. No more were built, and during the next three years they consumed the revenue without giving any proof of usefulness. In March, 1812, an act was passed directing that they should all be put out of commission. During the war the government got rid of them as rapidly as it could; and finally only three remained in the service, the rest having been sold for about one-tenth of their original cost.*

During this period the navy proper, apart from the gunboats, maintained a precarious existence. The government did not look upon it with favor, and its administration was none of the best. In 1806 Congress fixed the number of seamen to be employed at nine hundred and twenty-five; not enough to man three frigates.† The affair of the Chesapeake in 1807 was used as an argument for the abolition of the navy, on the ground that foreign nations would not inflict insults upon

*For a full account of the legislation in regard to gunboats, see Goldsborough's Nav. Chron., p. 322.

†Act approved April 21, 1806, § 3.

our ships-of-war if we had no ships-of-war to be insulted. Though foreign relations grew more and more complicated, the same arguments, or unreasoning denunciations, were repeated year by year in the debates on the appropriation bill. In 1808, in a debate upon increasing the force in commission, a representative from South Carolina said that "he was at a loss to find terms sufficiently expressive of his abhorrence of a navy. He would go a great deal further to see it burned than to extinguish the fire. It was a curse to the country, and never had been anything else. He had always voted against these high federal measures, and he thanked God he now had an opportunity to vote against them again." *

Strange as it may seem, these words represented the general opinion of the majority in Congress. The "abhorrence" was a matter of party discipline and party education. So strong was the hostility to the navy, that it is almost a wonder that the service was not abolished. But it found some defenders, men who, though in the minority, were not to be silenced by the partisans and intriguers who at that time controlled the legislature. It is a fact to be remembered by the navy, that in this period, when it was threatened with annihilation, it was ably and courageously supported by three statesmen from Massachusetts, in the Senate by James Lloyd, and in the House by Josiah Quincy and Joseph Story. Partly through their efforts, an act was passed early in 1809, directing the fitting out of the President, United States, Essex, and John Adams; and authorizing the preparation of the other ships, the appointment of three hundred midshipmen, and the employment of three thousand six hundred additional men. In the debate upon the bill, Quincy said: "I have been a close observer of what has been said and done by a majority of this House, and for one I am satisfied that no insult, however gross, could force this majority into a declaration of war. To use a strong but common expression, they could not be kicked into a war. What has this majority actually done during the two years in which the people have been kept in daily anticipation of war, toward the maintenance of our rights? We have built one hundred and seventy gunboats, and we have a hundred thousand militia in requisition. Do we mean to fight Great Britain with these? Are they competent to maintain our maritime rights?" † In the same

* Hon. D. R. Williams. The debate took place April 23, 1808. Ann. of Cong., 10th Cong., 1st sess., vol. 2, p. 2270.

† Ann. of Cong., 10th Cong., 2d sess., H. of R., Jan. 19, 1809.

debate an increase of the navy was recommended by Story, by the construction of fifty fast frigates. In reply to the objection that they would all be captured, he said: "I was born among the hardy sons of the ocean, and I cannot so doubt their courage or their skill. If Great Britain ever obtains possession of our present little navy, it will be at the expense of the best blood of the country, and after a struggle that will call for more of her strength than she has ever found necessary for a European enemy."* These predictions were amply fulfilled.

The act which followed this debate, and one passed in March of the same year (1809) to augment the marine corps,† were the last measures taken for the increase of the navy before the outbreak of the war. For three years, with the prospect of war staring it in the face, Congress did nothing in the way of preparation, not even during the long session of 1812, when the leaders were resolved to bring about hostilities. This was not from apathy or want of interest, but from an active spirit of opposition to what the party had been taught to look upon as a "high federal measure." In this very last year, though the naval committee recommended ten new frigates, Congress only appropriated enough money to fit out the Chesapeake, Constellation, and Adams; and as if a war with Great Britain meant a desultory conflict for half a century, it provided for an expenditure of $200,000 annually, for three years, towards rebuilding three or four of the small frigates, too rotten to be repaired.‡ With such encouragement the navy went into the war.

At the outbreak of the war the United States navy, exclusive of gunboats, was composed of twenty-one vessels, of which fourteen were in commission. Of the other seven, one was on Lake Ontario, three were repairing, and three were beyond repair. Of the fourteen in commission, there were three frigates of 44 guns, one of 38, one

*Ann. of Cong., 10th Cong., 2d sess., H. of R., Jan. 4, 1809, p. 977.

†Approved March 3, 1809.

‡Act approved March 30, 1812. The third section of this act, which provides for rebuilding, designates the Philadelphia, General Greene, New York, and Boston, as the four to be rebuilt. Exactly why the Philadelphia should have been specified as one of the ships to be rebuilt is not apparent, that vessel having been burnt by Decatur in 1804, in the harbor of Tripoli. The act might as well have named the Bon Homme Richard or the Alliance.

of 32, and one of 28; while the rest were sloops, brigs and schooners, carrying from 10 to 18 guns each.*

On the other hand there were in the British navy at the beginning of the year 1812, two hundred and thirty-six ships-of-the-line, of from 60 to 120 guns each, and six hundred and fifty-nine vessels of the class of frigates and smaller. These figures represent all the ships in the navy; of those actually in commission for sea-service there were one hundred and two ships-of-the-line, and four hundred and eighty-two frigates and smaller cruisers.†

The enormous disparity between our own navy and that of the enemy struck the government so forcibly at the outbreak of the war, that it was decided at Washington to lay up all the ships in commission. This was the logical extension of the administration policy. It was a self-denying measure of the same character as the embargo. It was founded upon the assumption that, as the enemy's force was overwhelming, it would be futile for us to keep up any force at all. The war-policy of the government seemed to be to make a declaration, and to scare the enemy with bluster, if possible, but to avoid any formidable preparations, which would lead their adversary to a vigorous pursuit of the war. Our safeguard and shelter from the resentment of foreign powers was to lie in their contempt,—a feeling which it was our interest studiously to cultivate. In applying this policy to the navy the Cabinet was overruled by the President, who had only been persuaded to change his mind by the earnest remonstrances of Bainbridge and Stewart.

Under these circumstances little or nothing was expected from the navy, and so it was that when, in the first eight months, three British frigates and three brigs or sloops-of-war were captured in engagements with single ships, the country was taken by surprise, and

*The list of vessels in full is as follows: President, 44, Rodgers, at New York; Constitution, 44, Hull, at Annapolis; United States, 44, Decatur, at New York; Chesapeake, 38, Constellation, 38, repairing under act of March 30, 1812; Congress, 38, Smith, at New York; New York, 38, to be rebuilt; Essex, 32, Porter, at New York; Adams, 28, repairing under the act of March 30; Boston, 28, to be rebuilt; General Greene, 28, to be rebuilt; John Adams, 28, cruising off the coast; Wasp, 18, Jones, returning from Europe; Hornet, 18, Lawrence, at New York; Argus, 16, Sinclair, at New York; Siren, 16, Nautilus, 12, Vixen, 12, Enterprise, 14, Viper, 10, cruising at various points off the coast; Oneida, 14, on Lake Ontario.

†Abstract (No. 20) of ships in the Royal Navy. James, Naval History of Great Britain, vol. 6, appendix.

was ready to believe in the invincibility of American men-of-war. Accounts were distorted and exaggerated until the notion became general—a notion which prevails more or less in the popular mind to this day—that the victories of American ships during the war were won over superior force, and through the display of extraordinary prowess. As a matter of fact, however, in nearly every engagement in which we were successful, we had a decided material advantage at the start, in the number and size of the guns, in the composition and size of the crews, and in the strength and general equipment of the ships. Moreover, the crews of American ships were in many cases superior in their discipline to the English, and, above all, their skill in gunnery was far in advance of their opponents. Many of these advantages must be set down to the credit of the officers, no less than the successful handling of the ships in action. The superiority in equipment was also largely due to the energetic and wisely-directed pressure of officers upon the naval administration. English officers, on the other hand, from long-continued success had grown slack, and the twenty years' war in Europe had exhausted the supply of good seamen, so that some of their ships on our coast were undermanned, or supplied with raw crews, pressed into the service. It was therefore doubtless due to the efforts of our officers that the advantages were on our side; still, there is no denying that in most of the single engagements we had the advantage.

As our officers had been careful and judicious in preparation, so they fought their actions with courage and skill; and our naval historians only injure their cause by seeking to represent them as victories won in the face of heavy odds. As far as bringing on an engagement was concerned, the American officers were generally less ready to do so than their opponents; and rightly, for the loss of a single ship would have been far greater calamity to the country than the loss of a dozen would have been to Great Britain. England might readily have sacrificed twenty frigates in bringing all our ships into action, and not have felt the loss seriously; while the series of actions would have extinguished our navy altogether. Thoughout the whole war, American commanders followed a far more cautious system of tactics than the English, and on several occasions chose to avoid a combat with a ship nearly equal, rather than risk the safety of one of our diminutive fleet. The event proved their wisdom: of the seventeen sea-going vessels that could be utilized at the beginning, ten were burnt or captured during the war. The seven that

escaped, comprising the Constitution, United States, Congress, Constellation, John Adams, Hornet, and Enterprise, were only saved by the exercise of the greatest care and prudence.

The English mode of fighting, on the other hand, which they had learned in their wars with the French, was to attack any enemy they met, even though the odds were very much against them, and either demoralize him by a tremendous fire at close quarters or carry him by boarding. Their great superiority in discipline and training, and their wonderful solidity and tenacity, generally gave them the victory. Their uniform experience had taught them to think little of manœuvering for advantages in sea-fights, and to set a far higher value upon sheer bravery and *élan* in making an attack. The Revolution of 1789, by introducing ideas of equality totally incompatible with discipline at sea, had disorganized the French navy; and, while in this condition, it received those crushing defeats from which it never recovered. In fighting with one of their ships, an enemy gained no special advantage by manœuvering; in fact, he needed none. The boldest plan was the safest; to go directly up to his antagonist, batter him for a while, and then board, if he had not already struck. Hence the tactical skill, the art of manœuvering, the quality which in land operations is called strategy or generalship, where it is the leading qualification for a great military commander, was regarded as a thing of little moment by officers of the school of St. Vincent and Nelson.

During the war of 1812, and especially at first, the English captains used the methods that had previously proved so successful; and having everything to gain by victory, and little to lose by defeat, they could afford to run greater risks than the Americans. They had learned to look upon an engagement with a larger ship as attended with little danger; and they were surprised in turn to find that the dashing tactics of European warfare were at fault. Their enemy was wary, and manœuvred at a distance, using his long guns to advantage; his gunnery was most accurate, and told at long or short range with far greater effect than their own; his tops were filled with riflemen, expert marksmen, who brought down a man at every shot. This explains the readiness with which the Guerrière, the Java, and the Macedonian engaged a superior force, and it explains also the rapidity and certainty of the fatal result. We cannot have too much admiration for these fine displays of courage on the part of the English captains; and we need not on that account think that the wary and cautious tactics of our own officers showed a want of bravery, for Congress

by its scanty provision for the national defence had forced this policy upon them. In discussing these actions, Sir Howard Douglas, a writer of great reputation in his day, commends this quality of the American officers to the English navy, in the strongest terms, under the name of *circumspection*. But Sir H. Douglas wrote after the American war; the word circumspection, applied in the same way in 1810, would have been regarded by Englishmen as a euphemism for cowardice. Now, it is a noteworthy fact that all our captains in the frigate actions of 1812, Bainbridge, Hull, and Decatur, whose personal courage nobody can deny, had used this circumspection when engaged with an inferior force; while Lawrence, in the engagement with the Shannon in the following summer, though he had far greater need of it, in that he was more nearly matched with his opponent, went into the action with impetuous bravery, scorned all tactical advantages, and, after a gallant and bloody struggle, lost his vessel.

Before going into the details of the war, one word about the various accounts of it. Soon after its close several books were published in the United States, filled with the brag and bluster for which Americans have sometimes been, justly or unjustly, condemned. The English official reports were not for some time made public, and some of these books having found their way to England, aroused the indignation of naval officers who knew the facts as they were. Hence the English naval historians have made it a special duty to answer these pretensions, and we may be said to have brought on ourselves much righteous reproach. The principal history of the British navy during the wars of Napoleon,—from 1793 to 1815,—is written by a lawyer named James, and is a wonder of careful and minute research. In the volume on the American war, however, he has lost or sunk all sense of fairness or candor, and his bitter hostility to Americans, and especially to American naval officers, has made him rather the advocate of a cause than the annalist of a contest. He has devoted himself in this volume, with all the ingenuity and skill of a special pleader, to proving that the officers of the American navy, one and all, with the exception perhaps of Lawrence, who was beaten, were cowards, liars, and blackguards. No charges can be too severe, no language too abusive to describe their conduct. According to James, they never fought when they could run away, they paid no regard to truth in their statements, they treated their prisoners with brutality, they resorted to the basest fraud and trickery to deceive an opponent. I know of no book in the language which contains such a mass of

malevolent misrepresentations of acts and of motives, such petty slurs upon men's characters, such dirty innuendos, and such coarse and vulgar abuse. Of course the book is a gross libel; but it is, nevertheless, the highest authority in England on the subject of the great naval wars. It is hardly necessary to say that the fascinating pages of Cooper, with which we are all so familiar, cannot serve as an adequate answer to James. A single page of James shows more research than any chapter of Cooper; and it has always seemed to me a pity that no American officer has been found to write a complete refutation of the slanders of the English historian.

On the 21st of June, three days after the declaration of war, a squadron sailed from New York under the command of Commodore Rodgers, composed of the President, as flagship; the United States, Commodore Decatur; the Congress, Capt. Smith; the Hornet, Capt. Lawrence; and the Argus, Capt. Arthur Sinclair. The object of the cruise was the capture of a fleet of one hundred merchantmen, known to have sailed from Jamaica some time earlier for England, with a convoy. When two days out, on the morning of the 23d, the squadron fell in with and chased the British frigate Belvidera, Capt. Byron, armed, according to James, with 42 guns. When the chase began the Belvidera was about six miles off; but, in the course of the afternoon, the President, which was the fastest ship of the squadron, came up within half a mile of her, and perhaps nearer, and opened fire from her bow guns, doing some damage. Presently one of these guns, a 24-pounder, burst, and killed and wounded several officers and men. Among the wounded was Commodore Rodgers. The Belvidera returned the fire with four guns which had been shifted to her stern ports. A running fight was kept up in this way for some time, and as the ships in chase were gaining on him, Capt. Byron cut away some of his anchors, threw overboard his boats, and otherwise lightened his ship. This had the desired effect, and the President gradually lost ground. At midnight the chase was given up as hopeless. The loss on each side was a little over twenty in killed and wounded; most of the casualties in the President resulting from the bursting of the gun. Unfortunately, the delay prevented the squadron from overtaking the Jamaica fleet; and, after following it across the ocean, the ships returned late in August to Boston, having taken seven prizes.*

* Commodore Rodgers's report, Nav. Mon., p. 205.

At the time that the squadron left New York, the Essex was lying there, undergoing repairs. She was under the command of Porter, about this time promoted to a captain. On the 3d of July, her repairs being completed, she sailed on a cruise alone. On the 11th, at night, Porter came up with several vessels, which he learned were British transports under convoy of the frigate Minerva. Porter's intention was to run alongside the frigate and surprise her; but finding himself unable to do this, he cut off the nearest transport. The Minerva discovered the capture, but went on her way without molesting the Essex. The prize was ransomed for $14,000. She had on board between one and two hundred soldiers, on their way to Quebec to take part in the war.*

About a month later, on the 13th of August, the Essex fell in with the British sloop-of-war Alert, which engaged her, apparently without perceiving the difference in force. The action lasted only eight minutes. After a few broadsides the Alert surrendered, the men deserting their guns in a panic. The sloop had seven feet of water in her hold, and three men wounded. The Essex had no injuries or casualties. This was the first capture of a public ship of the enemy made by us during the war. It was chiefly remarkable for the disproportionate injury to the two ships and for the short duration of the encounter. The Essex was far superior in the number and weight of the guns, in the number of men, and in the fighting qualities of the ship; while the Alert, according to the English account, was, except in the commander, badly officered and manned, and the result showed unfavorably for the discipline and gunnery of her crew.

The prize was fitted as a cartel and sent with the prisoners to Newfoundland. Porter returned to the Delaware in September. During the cruise he made nine captures, and recaptured five American privateers and merchantmen, fourteen prizes in all. Two of these were burnt, one was recaptured by the Belvidera, and the rest were sent in or ransomed.†

Before this time, an English squadron, composed of the Africa, a 64-gun ship, and the frigates Shannon, Guerrière, Belvidera, and Æolus, under Commodore Broke of the Shannon, had assembled on the coast, and was watching for our cruisers. About the middle of

* Niles' Reg., 2, 366; Porter's life of Commodore Porter, p. 93.

† Porter's reports, Nav. Mon., p. 211; Admiral Porter's life of Commo. Porter, p. 94.

July the Nautilus left New York, and, a few hours after sailing, fell in with this squadron. All the usual measures were taken to lighten the ship and to aid her escape, but after a six hours' chase she surrendered to the Shannon.

On the 12th of July, four days before the capture of the Nautilus, the Constitution, under Captain Hull, left the Chesapeake for New York. On the afternoon of the 16th, she fell in with Commodore Broke's squadron, off Barnegat. I will not here go into the details of the famous chase, with which every one is familiar, and which we can now read in the spirited narrative of one of the principal actors, the gallant first lieutenant of the Constitution.* On the 19th, after three days of incessant toil and anxiety, the ship finally lost sight of her pursuers, and a week later she arrived safely in Boston.

After a week in port, Hull sailed on a cruise to the eastward. He took and burnt some prizes in the gulf of St. Lawrence; and hearing that the squadron from which he had recently escaped was in the neighborhood, he steered to the southward.

On the 19th of August, at two o'clock in the afternoon, when at sea, in about the latitude of New York, the Constitution made a strange sail to the southward and eastward. Hull had already had information that an English frigate was cruising alone, to the southward of him, and he suspected that this was the object of his search, and accordingly bore down for her. The wind was NW, and the strange ship was sailing close-hauled on the starboard tack. At three o'clock the two ships were near enough to make each other out, and Hull's conjecture proved to be right. The stranger was the frigate Guerrière, of 38 guns, according to her nominal rating, which had left the squadron of Commodore Broke, and was on her way to Halifax.†

* The Autobiography of Commodore Charles Morris, U. S. N. Proc. U. S. Naval Institute, vol. vi. p. 159.

† Four distinct accounts of the action between the Constitution and the Guerrière have been written by eye-witnesses. They are the official reports of Captain Hull (Naval Monument, p. 9), and of Captain Dacres (Gold's Naval Chronicle, vol. 28, p. 347); the narrative of "an officer of the Constitution," (Nav. Mon., p. 12); and Morris's narrative (Autobiography, p. 163). The description of the engagement in the present article is based on a collation of the four accounts. Each of the accounts contains particulars omitted by all the others; but they agree in all essential points, except in regard to the duration of the action, which Captain Dacres makes about an hour longer than the other authorities. Upon this point it has appeared to me that the weight of authority rests with the Americans.

At four o'clock the Constitution altered her course to SSW, gaining rapidly on her opponent; and at 4.45, being then between two and three miles distant, the Guerrière backed her main-topsail and waited for the American ship to come up. Upon this the Constitution took in her topgallant-sails, staysails and flying jib, took a second reef in the topsails, hauled the courses up, sent down the royal yards, prepared for action, and beat to quarters. At the same time she bore up and steered for the Guerrière's quarter.

The two ships now closed. At 5 the Guerrière hoisted her colors, and five minutes later she began firing. According to the American reports, all her shot fell short. They were, however, returned with a few shots from the bow guns, and soon after the Guerrière wore, to prevent raking. The Constitution changed her course a little, to clear her opponent's quarter, and at 5.20 the latter fired a second broadside, and wore ship again. This manœuvre was repeated three or four times, the ship discharging alternate broadsides as they were brought to bear. Finding that these movements separated the ships, Hull set his main-topgallant-sail and steered directly for the enemy, who, finding at the same time that his manœuvres gave him no advantage, gradually bore up, and ran off under topsails and jib, with the wind on the quarter. The two ships were now heading nearly east, the Guerrière being still ahead and to leeward; but the Constitution closed rapidly up on her port quarter,* at 5.45, and passed to her beam, at a distance of two hundred yards, and approaching nearer. At 6.05 both ships opened fire, as their guns could be brought to bear.

At this point the action may fairly be said to have begun, as little or no injury had been inflicted on either side up to this time. In a few moments, the heavy fire from the guns of the Constitution, double-shotted with round and grape, began to tell, and at 6.15 Hull had the satisfaction of seeing his enemy's mizzenmast fall. The natural effect of the loss of after-sails would have been to cause the Guerrière to fall off before the wind, and this would have defeated Hull's purpose of passing alongside of her to windward and giving her a raking fire as he crossed her bow. In fact, this intention on the part of the American captain was so evident that the Guerrière's helm was put hard a-port to keep her head off. But, curiously enough, notwith-

*Captain Dacres, in his official report, says that the Constitution closed on his *starboard* beam; but this is evidently a mistake, as all the other statements show, and as James points out distinctly in his account.

standing the loss of after-sails, and notwithstanding the port helm, the Guerrière came up in the wind, swinging round into just the position most favorable for the execution of Hull's judicious plan. This was no doubt due to the fact that the wreck of the mast falling over the side acted as a drag.*

The Guerrière's velocity being now retarded, Hull gradually ranged ahead, and at 6.20 he put his helm hard a-port to cross her bow and rake her. The loss of braces on board the Constitution and the disabling of her spanker and mizzen-topsail prevented her from coming to starboard as quickly as was desired, but she had time to give two raking broadsides, which swept the enemy's deck, and which were only answered by a few of his bow guns. The Guerrière's jib-boom had just crossed the Constitution's quarter-deck when the latter bore up, putting her helm a-starboard, to avoid presenting her stern to the enemy's broadside. This manœuvre resulted in the entanglement of the enemy's bowsprit and jib-boom in the Constitution's mizzen-rigging, and the Englishmen prepared to board. Morris, the first lieutenant of the Constitution, seeing this, suggested to the captain to call away the men to repel boarders. This was accordingly done, but at the same moment Morris, who was standing on the taffrail and attempting to pass some turns of the main-brace over the Guerrière's bowsprit, to keep her fast, was shot through the body, and the two ships separated. During the period of close contact, the wads from the enemy's bow guns had

* The statements in regard to the fall of the mizzenmast rest on the authority of Captain Dacres, who says in his report (Naval Chronicle, vol. 28, p. 347): "Our mizzenmast went over the starboard quarter and brought the ship up in the wind." The statement is borne out by the narrative of the "officer of the Constitution," Nav. Mon., p. 13. It is not quite clear how the fall of the mast over the *starboard* quarter could have the effect of throwing the ship's head to port. Captain Brenton (Naval History of Great Britain, vol. 2, p. 453) gets over the difficulty by simply saying that it fell over the larboard side, notwithstanding Captain Dacres's statement to the contrary. Of course, if this was the case, the wreck of the mast acted purely as a rudder. James (Nav. Hist., 6, 99), having already changed starboard to port, where it occurs earlier in the report, seems to have felt a delicacy about taking further liberties with the statements of Captain Dacres, and leaves it on the starboard side, saying that "by dragging in the water it brought the ship up in the wind." If this statement is correct, it must have been due to the fact that the mass of the wreck falling some distance off, had a motion of its own, independently of the motion of the ship with which it was still connected by part of the shrouds or rigging, and, acting as a huge drag, it threw the ship's head around, in the same way that a steamer's stern line, made fast to a wharf, will throw her head off in the opposite direction.

set fire to the cabin of the Constitution, but the fire was quickly extinguished. A few moments later the Guerrière's fore and main-masts went by the board, and at 6.30 she fired a gun to leeward in token of surrender.*

The fate of the battle being now decided, Hull leisurely set his fore-sail and main-sail, and hauled to the eastward to repair damages. All the braces were shot away, the standing and running rigging was somewhat cut up, and some spars were lost. After passing half an hour in reeving new braces and in repairing the other injuries, he wore round and took a raking position to leeward of the enemy, within pistol-shot. Dacres meanwhile had been making a gallant effort to get his ship under command to renew the action, but after clearing away the wreck, his spritsail-yard, his only remaining reliance, was carried away, and the Guerrière lay a helpless wreck, in the trough of the sea, rolling her main-deck guns under water. When the Constitution returned to her at 7 o'clock, she surrendered.

Finding it impossible to take the Guerrière into port, on account of her shattered condition, Captain Hull set her on fire the next morning. She had then four feet of water, and was sinking fast. In the fight she had fifteen officers and men killed, and sixty-three wounded, six of them mortally. The Constitution received some injuries in her masts and rigging, though nothing that was not easily repaired. Her killed and wounded together amounted to fourteen.† The defeat was as overwhelming as it was unexpected. In half an hour's close action an English frigate had been compelled to surrender, dismasted, sinking, a complete wreck, with one-third of her force disabled.

To understand the merits of this engagement, and of those which followed, which created so much elation in America and so much depression in England, it is necessary to examine the construction and armament of the American and English frigates of the period. In the first place, we must drop out of our minds any consideration of the *rates* of men-of-war of this period, which were purely conventional, and bore a varying relation to the strength of the armament. The three largest frigates in our navy, the President, United States, and Constitution, were all nominally ships of forty-four guns, but

* Dacres says nothing in his report about having fired a gun to leeward, neither does Hull; but it is expressly mentioned by Morris, and by the "officer of the Constitution," whose succinct account was very generally published soon after the engagement.

† According to Hull, seven killed and seven wounded; according to Dacres, who could hardly be presumed to know accurately, nine killed and thirteen wounded.

in point of fact they usually carried fifty-six. On the other hand, the British 36 or 38 gun frigates carried from forty-five to forty-nine guns. In the second place, the guns themselves in the American frigates were much heavier than those in the British. There were two classes of guns on board of all these vessels, long guns on the gun-deck and carronades on the spar-deck. Of the latter, it is only necessary to say here that they carried a heavier shot than the others, but had a much shorter range; hence they required a smaller charge, and were shorter and lighter, and could be worked by a smaller number of men. Several of these were placed on the spar-deck. In the English frigates this was not a continuous deck, but consisted only of the quarter-deck and forecastle, connected by narrow gangways, but open in the middle to the gun-deck. As a rule, the English gun-deck battery consisted of 18-pounders, and the guns on the forecastle and quarter-deck were 32-pounder carronades, while our 44's had 24-pounders on the gun-deck and 42-pounder carronades above. The Constitution was an exception, however, in that she had 32-pounder carronades on her spar-deck, like the English frigates, instead of 42's, as in the President and the United States. She had originally been armed like the others, but the strain was found to be too great, and the change had been made the year before. She retained her 24-pounders, however, in her gun-deck battery. The only true way to estimate the effective force of these ships is by comparing the weight of their shot at a single discharge. According to this method, the battery of the Constitution was more powerful than that of her opponent by one-half.

In regard to other material advantages, that is, advantages which were not due in any way to the qualities of the officers and men, the size of the Constitution, her sailing qualities, the thickness of her frame, and the stoutness of her masts and spars, were all greatly in her favor. Moreover, her crew numbered about two hundred more than that of the Guerrière, and they were more generally picked men.*

* The force of the two ships is given by Emmons (Statistical History of the U. S. Navy, p. 56,) as follows:

CONSTITUTION: 468 men.

No. of guns.		Weight of shot.
30	long 24-pounders	720 pounds.
24	32-pounder carronades	768 "
1	long 18-pounder	18 "
55		1506 "

Taking all these facts into consideration, they do not account for the vast difference in the amount of injury inflicted. What then were the other elements of our success? It cannot be laid to extraordinary feats of daring; the conspicuous display of bravery lay rather with the smaller ship, which was ready for a plucky encounter with a superior force. It was not wholly in the discipline of the crew, though this was of the highest importance, and though the Constitution was remarkable in this respect, as was shown by the fortitude with which her escape was conducted a few weeks before. The all-important point of difference, the one which served us most during the whole war, was the practical training and skill of our crews in gunnery. They had constant exercise in target-practice, and, as James says, "ten shot, with the necessary powder, were allowed to be expended in play, to make one hit in earnest."* The English crews, on the other hand, rarely or never fired their guns except in an engagement, and stricts limits were fixed to the consumption of ammunition in gun-practice. Hence, in all our actions, a short time sufficed to disable the enemy; he was hulled repeatedly, and his masts were shot

GUERRIÈRE: 280 men.

No. of guns.		Weight of shot.	
30	long 18-pounders	540	pounds.
2	" 12-pounders	24	"
16	32-pounder carronades	512	"
1	12-pounder carronade	12	"
49		1088	"

Other authorities differ in some points from Emmons, but generally in unimportant points. James gives the Constitution 468 men and boys, and the Guerrière 244 men and 19 boys, and 6 Americans, who remained below (by Captain Dacres's order) during the action. In estimating comparative force, however, James always leaves the boys out of the account, because the English ships generally had a greater number than the American. Brenton (2, 455) gives the Constitution 476 men, following Dacres's report. Dacres gives the Constitution one additional 18-pounder, in which he is followed by James and Brenton, making a total of 56 guns. In regard to the Guerrière's armament, James puts two 9-pounders in place of Emmons's 12's, and makes the single launch-carronade an 18-pounder, instead of a 12-pounder as given by Emmons. This leaves the total number of guns and the weight of shot the same; though James, by a train of ingenious reasoning, which is thoroughly characteristic, endeavors to argue out of practical existence three of the guns of the English ship, thus reducing the number in his statement of "comparative force" to forty-six.

* Naval History of Great Britain, vol. 5, p. 373.

away, before he had accomplished more than a slight damage to our sails or our rigging.*

Another illustration of this is the action between the Wasp and the Frolic. The Wasp had left the Delaware on the 13th of October, and on the 18th met the brig Frolic, Captain Whinyates, at sea, about east of Albemarle Sound, in charge of a convoy from Honduras to England. As to armament, the two vessels were nearly matched. Each carried sixteen 32-pounder carronades, and from two to six additional guns, about the number and caliber of which accounts differ. The only long guns carried by the Wasp were two 12-pounders. She is also said to have carried two brass 4-pounders in her tops. The Frolic, according to a very explicit statement of Captain Jones, in his report of the action, carried, in addition to her carronades, four 12-pounders on the main deck, and two 12-pounder carronades on the top-gallant forecastle.† James denies that the Frolic carried six extra guns, and puts the number at four, two long sixes, and two 12-pounder carronades, one of which was lashed on the forecastle, and both of which he throws out of the calculation of comparative force.‡ No authority is given for these statements, and unless sustained by other testimony, they cannot be considered as of equal weight with those of Captain Jones, who had clearly the best opportunity of knowing. Captain Whinyates says nothing in his report about the force of either ship.§

In other respects, the advantages were on the side of the Americans. The officers and crew of the Wasp numbered one hundred and thirty-eight, while those of the Frolic, men and boys, only numbered

*The above was written before the discovery of the Morris autobiography. How far the views of the writer are borne out by the high authority of Commodore Morris may be seen from the following passage, relating to the causes of American success in 1812. "The remote cause, as it appeared to me, was to be found in the confidence of our enemy, and in distrust of ourselves to contend successfully against them; in the neglect of careful exercise, which resulted from the enemy's confidence, resting on former success; and, on our part, in the unwearied attention of our officers to devise and bring into daily exercise every improvement which might increase the chances of success against a navy to which we might soon be opposed as an enemy. . . . But the great source of our success was undoubtedly the superior management and direction of our guns; and that the English and other governments were satisfied of this is sufficiently evident by the careful attention they have since continued to give to this branch of the naval service."—Autobiography, p. 166.

†Jones's report, Naval Monument, p. 16.

‡Naval History, vol. 5, p. 112.

§Gold's Naval Chronicle, vol. 29, p. 76.

one hundred and ten. For the difference in the vessels themselves, the Wasp was heavier than the Frolic; added to which, in a violent gale the day before, the Frolic had carried away her main-yard, lost her topsails, and sprung her maintopmast; so says Capt. Whinyates' report. These accidents had a direct effect upon the engagement.

At about eleven o'clock in the morning, the Wasp bore down for the Frolic; the Frolic waited to receive her, and opened fire as she came near. After five minutes of close fighting, the Wasp's maintopmast came down, followed presently by her gaff and mizzen-topgallant mast. At the same time the Frolic's main braces were shot away, and she could therefore carry no sail upon her mainmast. This enabled the Wasp to take an advantageous position, and she accordingly stood across the Frolic's bow, with the English ship's jib-boom between her fore and main rigging. In this position the Frolic was boarded by the officers and crew of the Wasp, led by Lieutenant Geo. W. Rodgers; but on gaining the enemy's deck they found no one to oppose them but a handful of wounded officers and men. No resistance was made, and the Frolic's flag was lowered by James Biddle, the first lieutenant of the Wasp.

In this engagement, whatever disadvantages the Frolic may have been under at the start, her casualties were wholly out of proportion to them. She was much injured in her hull, and both her masts fell immediately after the action. She had fifteen killed and forty-seven wounded, some of them mortally; while the Wasp had only six killed and five wounded. The action was fought in a heavy sea, under very little canvas; but even so, the precision of the American gunnery was far superior to that of the enemy. It is said that the Americans fired as the engaged side of their ship was going down, and the English as theirs was rising; which explains, in some measure, the difference in the damage each received and inflicted. Soon after the engagement both ships were taken by the Poictiers, a seventy-four, which came in sight before any preparations for flight could be made.

On the 8th of October, Commodore Rodgers left Boston with the same vessels he had commanded before, except the Hornet. These vessels were the frigates President, United States, and Congress, and the brig Argus. On the 12th, the United States and Argus separated from the squadron, themselves going different ways. The Argus cruised for three months in the north Atlantic, took a few prizes, and

returned to New York early in January. The President and Congress were peculiarly unfortunate in meeting few merchantmen, and they returned to Boston on the last day of the year, having made only two captures in the three months.

When the United States, under Captain Decatur, left the other vessels, she cruised to the SE, and on the 25th of October, at sea, some distance to the west of the Canary islands, she fell in with the British 38-gun frigate Macedonian, Capt. Carden. The difference in the relative force of the ships was even greater than in the case of the Constitution and Guerrière, as the United States had 42-pounder carronades instead of 32's, and on the other hand the Macedonian lacked two of the Guerrière's long 18-pounders, and their place was supplied by 9's or 12's.* When the ships first sighted each other, at daylight, they were twelve miles apart, the Macedonian going before the wind, and the United States to the north of her; the wind was SSE, and the United States was close-hauled on the port tack. In this way they gradually neared, but at 7.30, Decatur, uncertain as to the force of the enemy, wore and stood off. The Macedonian continued on her course, and would soon have overtaken

*The armaments of the two ships were as follows:

UNITED STATES: 478 men.

No. of guns.		Weight of shot.
32	long 24-pounders	768 pounds.
22	42-pounder carronades	924 "
1	18-pounder carronade	18 "
55		1710 "

MACEDONIAN: 297 men and boys (James); 306 (Emmons).

28	long 18-pounders	504 pounds.
2	" 12-pounders	24 "
2	" 8-pounders	16 "
16	32-pounder carronades	512 "
1	18-pounder carronade	18 "
49		1074 "

All accounts agree substantially in regard to the armament; the main point of difference being in the omission by American authorities of the 18-pounder carronade on board the United States. Its presence is asserted by Capt. Carden in his report, and as there is no authoritative statement to the contrary, it is placed in the table.

her opponent, when the latter wore again with a view to closing. At this point, according to the English historian, Captain Carden should have kept on his course and run across the bow of the other ship (as indicated by the heavy line in the diagram), and he was advised to do so by his lieutenant. But he preferred to keep the weather-gage, and passing to windward of his antagonist, they exchanged the first broadsides at 9 o'clock. The Macedonian now wearing followed her opponent on the same tack, and at 9.20 came up with her quarter; at this point the fight may be fairly said to have begun. The first broadsides carried away the mizzen-topgallant-mast of the United States and the mizzen-topmast and gaff-halliards of the enemy; this produced an equality in sailing, and enabled the United States to oppose the guns on her quarter to those on her enemy's bow in a running fight. The diagonal fire from the United States proved very effective, but at 10.15 she backed her main-topsail and allowed the enemy to come up with her.

As soon as the ships were abreast, there began that tremendous disabling fire of the Americans which had been the main element in their previous successes. In the course of half an hour the Macedonian's mizzen-mast was shot away, her fore and main-topmasts gone, what was left of her masts and rigging badly cut up, her upper battery, with the exception of two guns, disabled, one-third of her crew killed and wounded, and one hundred shot in her hull. The English fought with great bravery and tried to get on board the United States, but the ship would not answer the helm. The fight was now practically over, but the supply of filled cartridges on board the United States having given out, she drew off, refilled her cartridges at leisure, tacked and returned to a commanding position on the stern of the enemy, who immediately surrendered.

In this action, the same facts are noticeable as in the earlier engagement, but in a more marked degree. The odds at the start are strongly in favor of the Americans, in the size and strength of the ships, in the number and still more in the weight of the guns, in the number of men. The English tactics are bold, dashing, more so than in the action of the Guerrière; the English captain manœuvres carelessly and neglects his advantages. The Americans, on the contrary, mindful of their "pigmy navy," as the English papers called it,* and the great loss to the country that would follow the destruction of a

* Nav. Chron. 29, 198.

single frigate, are wary and cautious to such an extent as almost to decline an engagement, and to lead their enemies to charge them with cowardice: a charge which no one certainly could more easily repel than Decatur. The accurate and careful gunnery of the Americans and the great rapidity of their fire quickly disable the enemy, carry away his masts, shatter his hull, silence his battery; while in return he inflicts little or no injury. The inequality in the loss of men is still more striking. The Americans have only seven killed and six wounded; while the English loss foots up to the comparatively enormous total of thirty-six killed and sixty-eight wounded. Even in the capture of the Guerrière, the American ship hauls off when the engagement is practically at an end, to renew her preparations, and after attending to these matters at her leisure, she only returns to receive a final surrender.*

Not long after the beginning of the war the government had resolved to send a squadron to the south Pacific, to destroy the unprotected British commerce in that quarter. With this object, on the 27th of October, shortly after the capture of the Macedonian, the Essex, still under Captain Porter, left the Delaware, and a few days later the Constitution, now commanded by Captain Bainbridge, and the Hornet, Captain Lawrence, left Boston. The ships were to rendezvous at Bahia, and other ports on the Brazilian coast. As is well known, the Essex missed the other ships, and went on the intended cruise alone. The Constitution and Hornet reached Bahia near the end of December, and the Hornet was sent in, Commodore Bainbridge remaining alone in the neighborhood of the coast.

On the 29th, at 9 o'clock in the morning, as the Constitution was sailing by the wind on the port tack, the wind being from the NE, two vessels were seen in the NNE. These were the British 38-gun frigate Java, Captain Henry Lambert, and an American merchantman, a prize of the Java. The prize was cast off and sent into Bahia, but before her arrival was recaptured by the Hornet. The Constitution tacked, and the two opposing vessels now stood for each other; but after a time the Constitution, finding her signals unanswered, went about and stood to the southeast, to draw the Java away from her companion, which in the distance Bainbridge mistook for a ship-of-war.

About noon the Java hauled up, steering a course parallel to the Constitution. As the morning passed away she came rapidly up, and

* Captain Carden's report, Gold's Nav. Chron. vol. 29, p. 77; Commodore Decatur's report, Nav. Mon. p. 24; James, Nav. Hist. vol. 6, p. 114.

was made out to be an English frigate. At 2 P. M. the two ships were within half a mile, the Java to windward, and the firing began. They were both sailing by the wind, in the same direction as that of the Constitution, when the enemy was first sighted. At 2.20 the Constitution wore to avoid being raked; the Java wore also, and the ships being again side by side on the starboard tack, exchanged broadsides, by which the wheel of the Constitution was entirely shot away. Again the Constitution wore, and the Java, performing the same manœuvre, at 2.35 passed just astern, and missed an excellent opportunity of raking her opponent. At 2.40 she again passed the stern of the Constitution, and this time fired a few guns. Immediately after, the Constitution luffed up close to the Java, and for a few minutes the action was spirited; here the head of the Java's bowsprit was shot away. At 2.52 the Constitution wore again, and the Java, as the quickest way to get about, tacked; but after coming up in the wind, she paid off very slowly, from the want of head-sails. As she was in the midst of this operation, the Constitution, seeing her opportunity, luffed up astern of her and gave her a raking fire; then wearing again, she resumed her course, and the Java once more got alongside. Here the decisive part of the engagement began. At eight minutes after 3, as Captain Lambert, foreseeing the inevitable result, was preparing to board, and with that view was bearing up towards the Constitution, the Java's foremast fell and prevented the attempt. At 3.15 the Constitution wore across the Java's bows, and brought down her maintopmast; then luffing up to leeward of her, poured in, first her starboard, and then, wearing, her port broadside. Remaining alongside in this last position, she continued a heavy fire, carrying away the gaff and spanker, and finally the whole mizzenmast. Before this, Captain Lambert had fallen, mortally wounded, and the command of the Java devolved on Lieutenant Henry Chads, who still continued bravely defending her. Soon after four, her fire ceasing and all her flags being down, Bainbridge supposed she had surrendered; and then he performed that manœuvre which we noticed in the actions of the Guerrière and the Macedonian, of hauling away from his disabled enemy and leisurely repairing his own injuries. From the remarkable similiarity in the method of the three captains, Hull, Decatur, and Bainbridge, one might almost suppose it was a regulation of the department. As in the other cases, Bainbridge returned in about an hour, and took up a raking position, only to receive the formal surrender of his adversary.

It is hardly necessary to go over all the points of resemblance between this case and the other two,—points upon which we have already dwelt at length. The relative force in guns was about the same as in the fight with the Guerrière; while the crews were more nearly equal, owing to the presence on board the Java of a large number of supernumeraries. As far as one may judge from conflicting statements, there were about four hundred and eighty officers and men on board the Constitution, and about one hundred less on board the Java. The difference in the killed and wounded was very great, the Java having twenty-two killed and one hundred and two wounded; while the Constitution had only nine killed and twenty-five wounded. At the close of the engagement, the Java was such a wreck that she could not be carried into port; while the Constitution, though she gave up her cruise in the Pacific, had no difficulty in returning to the United States.*

After the departure of the Constitution, the Hornet remained off Bahia, blockading the English sloop-of-war Bonne Citoyenne, which was lying in the harbor. After three weeks thus occupied, she was driven off by the arrival of the 74-gun ship Montague. She now cruised for some time off the coast of Brazil and Guiana, and captured two valuable prizes. On the 24th of February, at the entrance of Demerara river, the Hornet discovered a vessel-of-war on her weather quarter, edging down for her. This was the English brig Peacock, commanded by Captain William Peake, and mounting sixteen 24-pounder carronades and two long 6-pounders. The Hornet, as soon as she made her out to be an enemy, cleared for action, and kept close by the wind, to get the weather-gage. This was some time after four o'clock in the afternoon. At ten minutes after five the Hornet tacked and passed close to windward of the enemy, the two ships exchanging broadsides. As the Peacock wore after passing, the Hornet bore up, received the starboard broadside of the enemy, ran him close on board his starboard quarter, and kept up such a heavy and direct fire that in less than fifteen minutes he surrendered; "being literally cut to pieces," as Lawrence says in his report. Immediately afterward the mainmast of the Peacock fell, and a signal of distress was hoisted. It was found that she was sinking rapidly, having three feet of water. Every effort was made to save her, and the prisoners were taken off as quickly as possible; but before the work was fin-

* Bainbridge's report and journal, Nav. Mon. pp. 28, 32; Lieutenant Chads' report and address to the court, Gold's Nav. Chron. vol 29, pp. 346, 403.

ished, she went down, carrying with her thirteen of her crew and three men from the Hornet. Captain Peake and four men were killed in the action, and thirty-three wounded. The Hornet lost only one killed and four wounded,—two of the latter by the bursting of a cartridge. Her rigging and sails were somewhat cut, but her hull had little or no damage. It was, like most of the others, a victory over a somewhat inferior force, in that the Hornet was armed with 32-pounders against her opponent's 24's; but it was a victory of a remarkably quick and successful character.* The Hornet immediately sailed for home, and arrived at Holmes' Hole on the 19th of March.

Besides the Wasp and the Nautilus, only two vessels of the navy had been captured during this period. One of these was the brig Viper, captured by the British 32-gun frigate Narcissus, in January, 1813. The other was the brig Vixen, so closely associated with the Nautilus in Preble's operations against Tripoli. Both vessels were built or bought in 1803, and both were altered from schooners to brigs in 1810. The Vixen carried twelve 18-pounder carronades and two long 9-pounders. At the time of her capture, Nov. 22, 1812, she was cruising among the West India islands, under the command of Master-Commandant George W. Read. She was taken by the British frigate Southampton, of 32 guns, commanded by Sir J. L. Yeo, after a chase in which every effort had been made to escape. Soon afterwards, both vessels were wrecked on one of the Bahama islands.†

As no further engagements of any consequence between national vessels took place until the action between the Chesapeake and Shannon in June, we may say that the events related comprise the first year of the naval history of the war. What had been the results? During this period, the navy had captured in single engagements three frigates and three brigs or sloops-of-war. At the outbreak of the war

* Possibly there was a considerable disparity in men, as well as in weight of metal, between the two ships. Emmons places the force of the Hornet at one hundred and thirty-five men, and that of the Peacock at one hundred and thirty. James makes the respective complements one hundred and sixty-five and one hundred and twenty-two. But as neither of these writers quotes any authority, it is hard to say which is correct. Lawrence in his report (Nav. Mon., p. 33) says that the Peacock's crew, according to her quarter-bill, consisted of one hundred and thirty-four men, four of whom were absent on a prize; but I have met with no authentic statement of the Hornet's complement. As Admiral Emmons had access, however, to the files of the Navy Department, his statement must be accepted as the most trustworthy that we have.

† Nav. Mon., pp. 215, 227.

we had six frigates and eight small ships or brigs in commission; while upon the coasts of America were three squadrons of the enemy, any one of which was a match for all of ours. On the Halifax station there were twenty-four vessels, frigates and brigs, not counting the schooners; on the Jamaica station twenty-two, and among the Leeward islands seventeen.* And all that this immense force, more than three times the size of our own, could accomplish was the capture of one sloop-of-war, the Wasp, disabled after an engagement, and three diminutive 12 and 10-gun brigs, one of which was taken by a squadron. The results more than justified the cautious tactics of our officers. It was only in a wise husbanding of resources that any result was attained; here lay the secret of an end so marvellously disproportionate to the means.

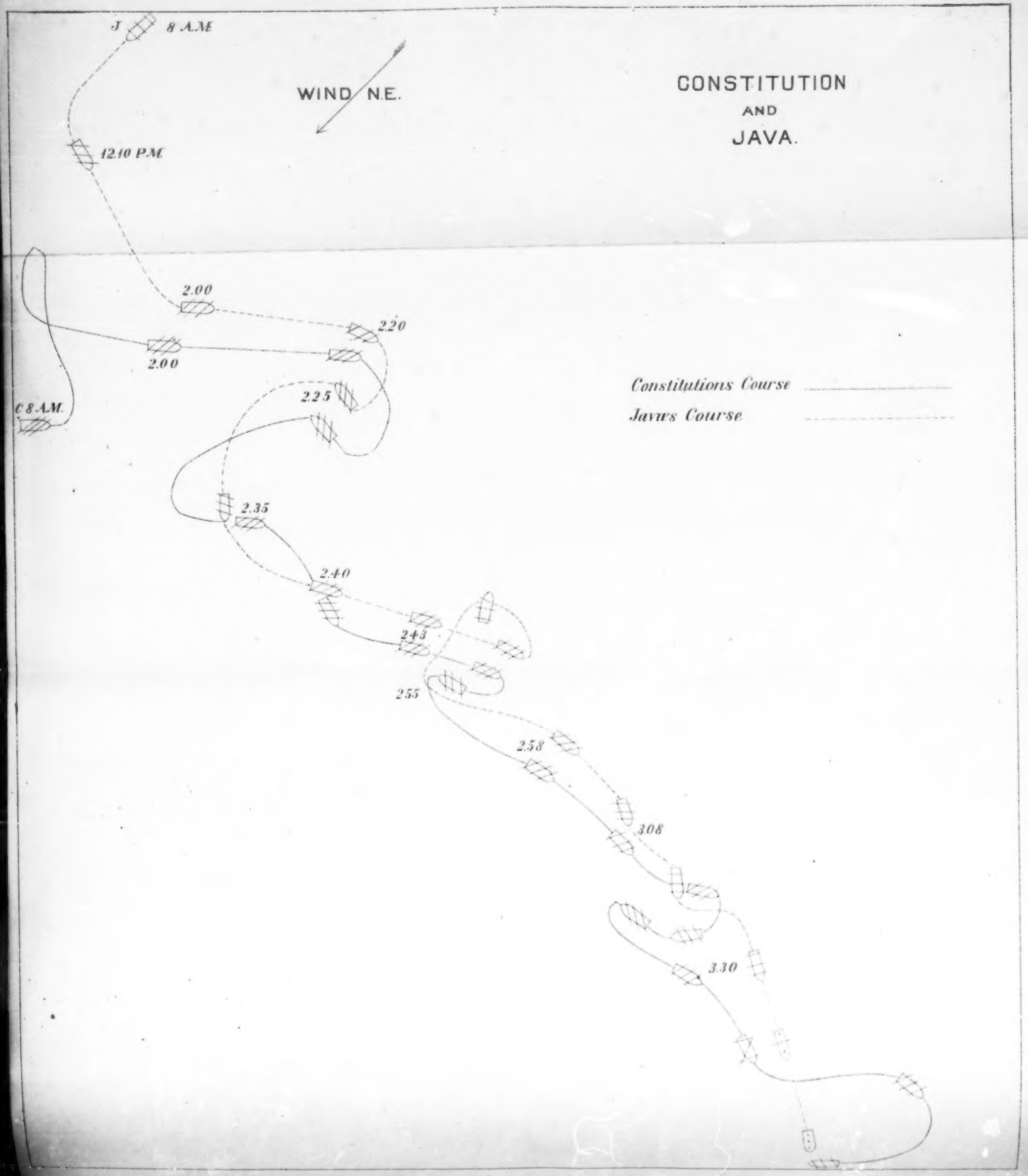
To the results of the great engagements must be added the vast number of merchantmen made prizes by privateers as well as by national cruisers. Of these over four hundred and thirty were reported in this first year, without counting recaptures, of which there were a great number. This was a loss that touched the enemy more materially, at the moment, than the capture of six men-of-war, in a navy whose ships were counted by hundreds. It was only the moral significance of the great sea-fights that made them so important. For twenty years, English ships had been accustomed to victory over every enemy, even in the face of heavy odds. The nation looked upon them as invincible. Upon its maritime superiority the government based pretensions which, if admitted, would have made commerce an English monopoly. Englishmen only knew of American policy and American armaments to despise them; and when the war broke out, it gave them little concern, and it was the intention of the government to prosecute it at leisure in the enemy's country. The capture of the Alert was looked upon by English officers as an accident, a thing of no moment, which was only to precede the extinction of the little American navy. The loss of the Guerrière astonished them for an instant, and served, at least, to establish the fact that the Constitution was something more than a "bundle of pine-boards, under a bit of striped bunting," as she had formerly been called in derision. But as loss followed loss, and capture followed capture, as they saw the Frolic, the Macedonian, the Java, and the Peacock successively taken, the revulsion of feeling was tremendous. The journals and magazines were filled with letters and

* Niles's Reg., 2, 356.

essays, with minute calculations aiming to show the enormous advantage possessed by the vessels they had derided. The naval administration was attacked, and called upon to take more energetic measures. Ships-of-the-line were razeed for the express purpose of fighting the President and the Constitution to advantage, and the squadron on the American coast was reinforced by some of the most powerful ships in the navy. As a Boston paper wittily put it, the English, in the spring of 1813, were sending out frigates to America under convoy of line-of-battle ships. But the most important effect of American victories was to show the hollowness of English pretensions to the control of the ocean. In view of the possibilities of future wars, it was idle any longer to advance the theory so arrogantly put forth by English writers, that "the frontier of England was high-water mark on every shore, and the British seas were wherever a 32-pounder could be floated."*

The course of events had produced a result no less marked in America. Doubtless in the enthusiasm of the moment, circumstances were exaggerated and distorted; but however they might be presented, the fact remained that American ships had beaten their enemies. The navy suddenly became the most popular branch of the public service; and its popularity was redoubled by comparison with the reverses of the army, whose campaigns in the north had been one long series of almost uninterrupted disasters. The war party, the party of the democratic republicans, was now only too ready to pet and patronize the navy, which it had hitherto so steadily opposed; while the justification of the "high federal measure" of former years half reconciled the federalists to the war. As the news came of victory after victory, each one so decisive and so unexpected, the most bitter partisan could not help feeling a glow of enthusiasm; and the country at last learned to look upon the navy as its only real protection, as the securest defence of the national honor.

* Gold's Nav. Chron. 29, 198.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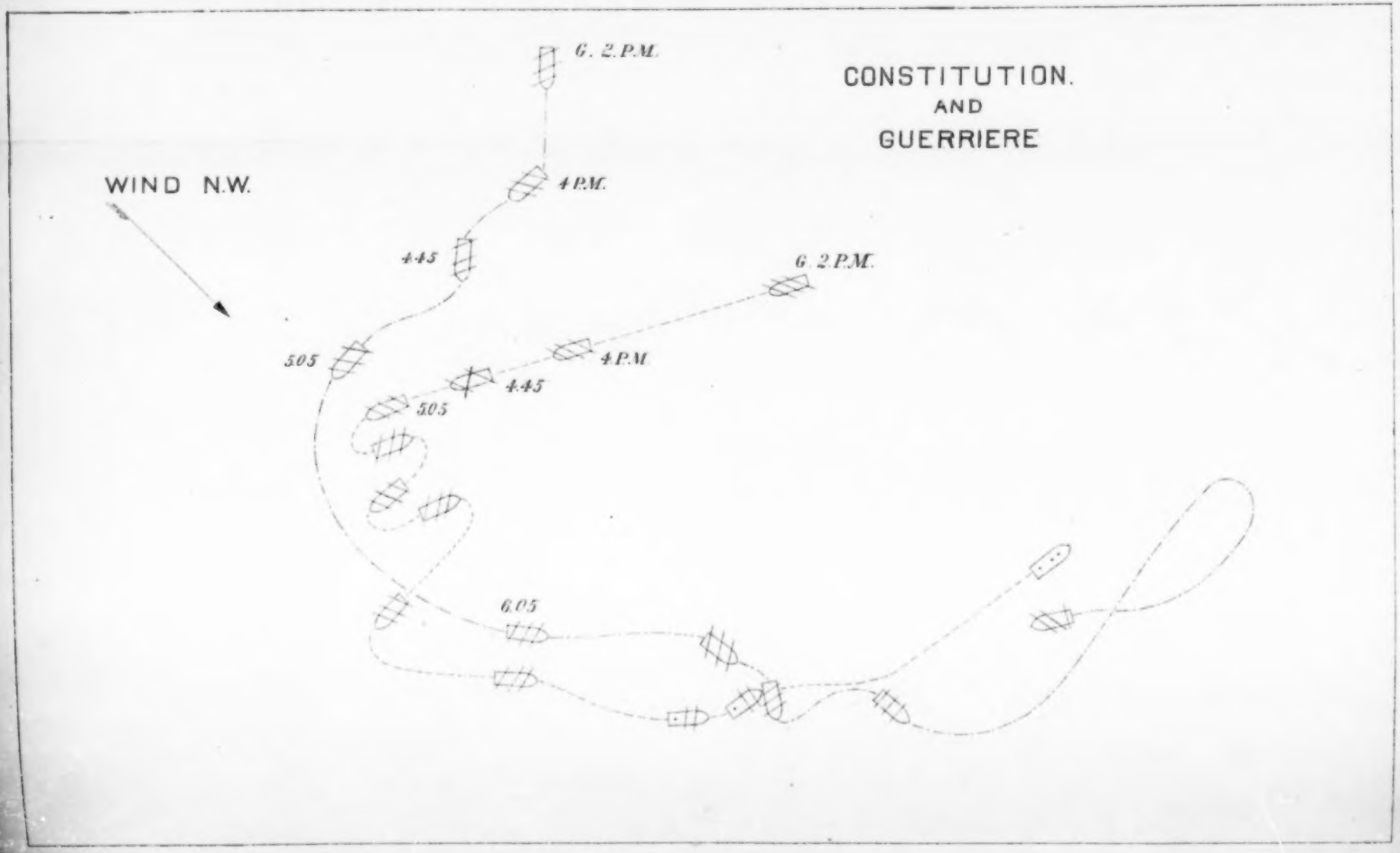
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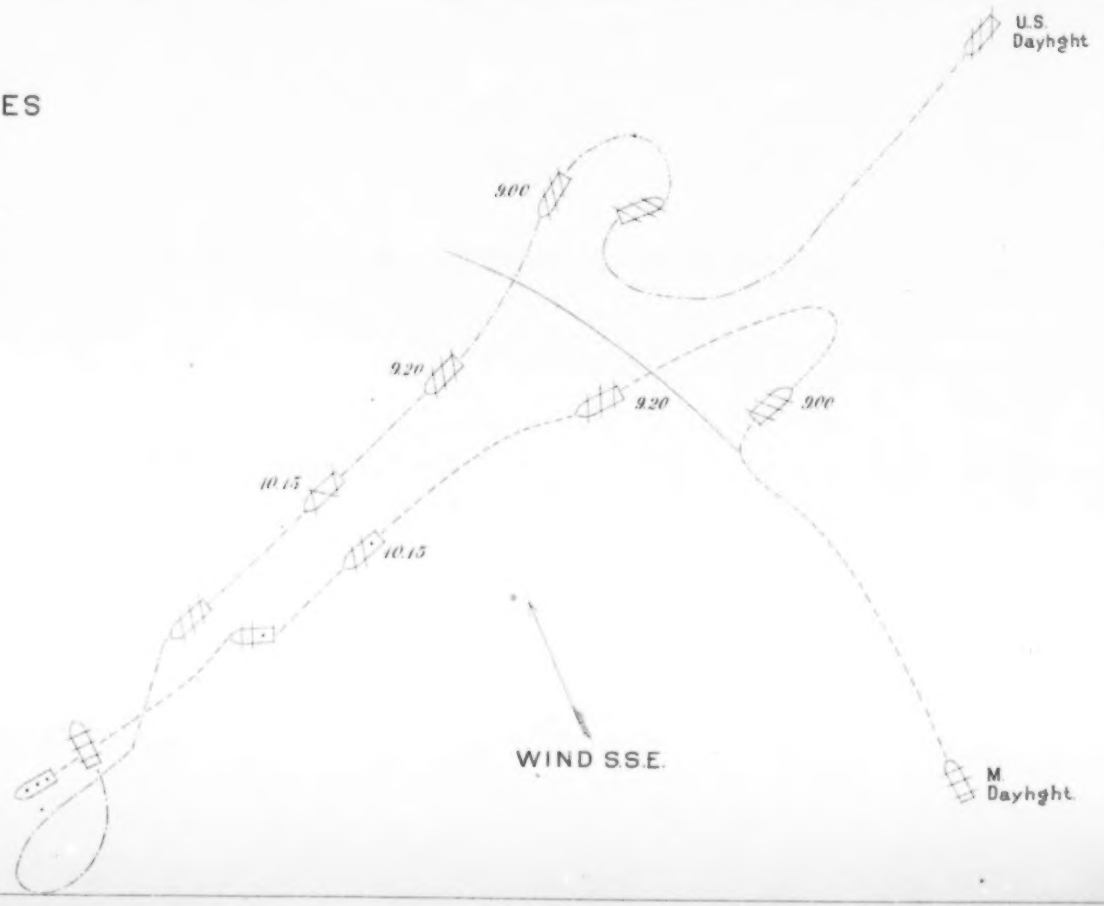


NAVAL INSTITUTE, ANNAPOLIS, MD.

NOVEMBER 16, 1881.

COMMANDER H. B. ROBESON, U. S. N., in the Chair.

THE LEE SYSTEM FOR SMALL ARMS.

BY MR. JAMES P. LEE, PRESIDENT OF THE LEE ARMS COMPANY.

[illegible] the muzzle-loading [illegible] decided upon the field of Antietam, [illegible] in so many cases [illegible] used [illegible] more than one cartridge, [illegible] showed the necessity of adopting for general use a breech-loading system which would not allow escaping gas, and the Austro-Prussian war had demonstrated the superiority of breech-loading small arms, and after the perfecting of metallic ammunition had rendered breech-loading entirely practical, the United States government, in 1872, ordered a board of officers to consider all the breech systems attainable and select one for army use.

In the report of that board to the Secretary of war it was:—"Resolved, That in the opinion of the Board, the adoption of magazine guns for the military service of all nations is only a question of time; that whenever an arm shall be devised which shall be as effective, as a single breech-loader, as the best of the existing single breech-loading arms, and at the same time shall possess a safe and easily manipulated magazine, every consideration of public policy will require its adoption."

I have endeavored to produce such an arm, and, after some years of experimenting, have produced an arm whose points I would desire to present to the members of the Naval Institute, leaving it for them to decide how nearly I have fulfilled the wants of the board as expressed in the above-quoted resolution. The general military opinion of the world has decided that the breech-closing mechanism for small arms

shall be of the bolt type, and accordingly for my system I have adopted a bolt in the design of which I have endeavored to attain the requisites of simplicity of construction, strength of system and certainty of action; and have succeeded so far in producing one with fewer parts than any bolt in use, capable of being entirely dismounted and assembled with no other tool than a penknife or an empty cartridge-shell, having no screws about it to jar loose, having a powerful, easy, and certain extraction, and having a long travel to the firing pin, a long main spring and the consequent ability to function certainly with comparatively little work on the spring. The bolt lock, functioning when the piece is brought to half-cock, is of such a design that the metal of the bolt must be bodily sheared away before the lock can refuse action. Repeated blows with a mallet upon the bolt handle fail to force the lock even when the arm is held fast in a vise. The receiver is of such construction that the recoil is taken upon lugs that drop below the line of the panel and abut upon shoulders in the stock, "in the straight of the wood," *i. e.* in line with the straight wood through the small. The stock shows no sign of failing when dropped from a height upon the butt plate, or under long continued firing tests. When the magazine is not upon the gun, a bottom to the receiver is formed by a simple device, so that the gun is then a single loader pure and simple, and, it would seem, a weapon that possesses the first requisite demanded by the board, viz., that the arm "shall be as effective as a single breech-loader as the best of the existing single breech-loading arms."

As regards the second requirement of the board—"and at the same time shall possess a safe and easily manipulated magazine,"—I have endeavored to make the magazine *safe* by so arranging it that, when charged, the cartridges it contains can in no way receive a dangerous shock upon the primers, either by blows or by concussion due to recoil; and I have attempted to make it "easily manipulated" by so designing it that the manipulation consists in slipping a 3½ ounce steel box into a free slot, pressing it home, or driving it there with a tap of the hand; and touching a catch conveniently placed in the trigger-guard before withdrawing from the slot. It is submitted that in the present condition of arms-making it is hard to conceive of an easier manipulation.

The charging of the magazine consists in pushing in the required number of cartridges, one on top of the other laterally, not one before or behind the other as in tubular magazines. An ordinarily intelli-

gent man will charge a magazine containing five cartridges in as many seconds, while he will find it impossible to get in a cartridge in a wrong position for feeding up. The magazine is detachable, and being detachable, it can be lost. This is an apparent disadvantage of the system, but in deciding whether or not it really be so, I would ask consideration of the following propositions: If it be non-detachable, the arm cannot fulfill the first requirement of the board's resolution, and "be as effective as a single breech-loader as the best of the existing single breech-loading arms"; for an attached magazine implies the increased weight of arm due to the charged magazine —which must be kept charged to be always ready for the "crit moment," for which magazine fire is wanted—and a complicatio parts in the necessary "cut off" device by which the magazine cha can be held in reserve. The magazine of my system is no more and no less detachable than is the cartridge, and when charged may be considered as a cartridge capable of delivering five rounds and of being as easily placed in the gun as is the single one, while it would seem from its size and shape not so readily dropped and lost. Each man may be provided with such a number of magazines—four or five—that the loss of one or two will not disable the gun as a magazine arm; if all the magazines be lost the gun is still an effective single-loader that cannot be disabled by accident to the magazine parts; the magazines are so inexpensive that the loss of them is financially small, and almost inappreciable in comparison with the advantage of having no "cut off" to confuse the men at the "critical moment." Finally, the magazine catch can be permanently locked and the magazine thus made a detachable one.

If, as is generally conceded, the small-arm fire in the naval actions of the future is to be poured in as rapidly as possible during the few seconds of the struggle for a close action, my system would seem to be well adapted for naval uses; for the small-arm men on deck could be provided with five or six charged magazines,—in loops or pockets on the waist belt,—that could be emptied against the enemy with great rapidity, while the riflemen aloft, provided with a small chest filled with charged magazines, in each top, would be unencumbered with belts and cartridge-boxes when needed for duties in the rigging. For landing, the men could be provided with an allowance of ammunition in the ordinary cartridge-box for single loading use, and hold in reserve the charged magazines in pockets on the left side of the waist belt.

LT. MASON: During Rear Admiral Stevens' last inspection of the Wachusett on the Pacific station I was ordered to pay particular attention to the repeating arms with which the riflemen of her crew were armed. I found that very few of the men, although otherwise they showed themselves to be well instructed, could explain or use the cut-off when flurried by the excitement incident to the inspection. Such a thing in action, where the excitement would have been much greater, would have entirely neutralized the benefits of the firearm, if they had not actually rendered it objectionable.

I am in doubt whether any but good shots should be armed with repeating or magazine arms, although on some occasions, notably at Plevna, they have proved invaluable when not aimed at all. For the good shots I think that a very rapid firing many cartridge magazine gun is the proper arm, and especially for ship work at the moment of ramming or passing. The Lee gun with its easily interchangeable magazine would seem to meet our wants, especially if the supply of filled magazines at hand were large. Under most circumstances a few good shots, well provided with filled magazines, capable of directing their fire to many parts of an enemy, would be more effective than a small bore machine gun.

During the war between Chile and Peru and Bolivia, several events showed how a power to greatly increase small-arm fire at any moment was most effective and an inability to do so was fatal. Had Pratt and Lerano had magazine arms when they boarded the Huascar from the sinking Esmeralda, the result of that battle might have been changed, as but few of the Huascar's crew were prepared to resist even the handful of boarders.

The small-arm fire from the twelve men in each of the forward tops of the Chilian ironclads at Arica was so well sustained that they drove the crew away from the Huascar's gatling in her top, and caused it to be currently reported that instead of riflemen they were machine guns.

The Germans have adopted a detachable magazine gun, somewhat similar to the Lee, and seem to be well satisfied with it both in their land and sea services.

The French have a repeating rifle, and are not entirely pleased with it in the hands of troops, and especially in those of sailors.

LT. COMDR. THOMAS: I would like to call attention to the greater facility of aiming with the Lee gun than with any other magazine gun yet proposed. The position of the magazine is well placed for nicely balancing the weapon, and the center of gravity is not materially altered as the magazine becomes exhausted.

THE CHAIRMAN: I have listened to the reading of this paper with much interest; especially as it appears to me to involve a new principle in the construction of repeating arms.

The principle to which I allude is in the position of the magazine, which in the Lee repeating rifle seems to reduce to a minimum, if not to entirely obviate the very serious objection of the derangement of aim, and consequent want of accuracy, resulting from a constant change of the center of gravity of the piece on the emptying of the magazine. As this subject has already been spoken of

this evening, I will pass to one or two other points which appear to be worthy of attention.

One notably distinctive feature of this arm is in the attachment of the magazine, which is entirely separate from the gun, so that the piece may be either used as an ordinary breech-loader or used as a repeating arm. In other systems of repeating rifles the magazine is charged by introducing the cartridges one by one; in this system, the whole magazine is attached with the same facility with which a single cartridge can be charged. In other words, the gun either fires one or five rounds, and loads both equally well.

Apart from these distinctive features, the gun appears to be simple in its mechanism, and in this respect seems to be particularly adapted to the wants of general service.

PLATE I.

Fig. 1.

Lee System Open, with Magazine Detached.

Fig. 2.

Lee Military Rifle, with Magazine in place.
Weight, nine pounds.

PLATE II.

Component Parts of the Lee Bolt System, without Magazine Mechanism.

A. Receiver.
B. Bolt.
C. Firing Pin
D. Main Spring.
E. Thumb Piece.
F. Key Sleeve.
G. Extractor.
H. Sere.
I. Trigger.
L. Sere Spring.
O. Guard.
Q. Extractor Spring.
R. Tang Screw.
S. Guard Screw.

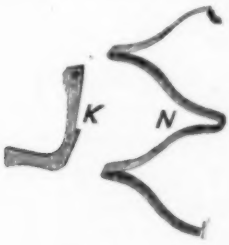
PLATE III.

Sectional View of Lee System, with Magazine in place.

A. Receiver.
B. Bolt.
C. Firing Pin.
D. Main Spring.
E. Thumb Piece.
F. Key Sleeve.
G. Extractor.
H. Sere.
I. Trigger.
K. Magazine Catch.
L. Sere Spring.
M. Magazine.
N. Magazine Spring.
O. Trigger Guard.
P. Stock.
R. Tang Screw.
S. Guard Screw.

PLATE IV.

Weight of Magazine and Spring, 3½ ounces.

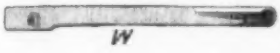


MAGAZINE MECHANISM.

Component Parts.

K. Magazine Catch. N. Magazine Spring.

M. Magazine.



The Spring W serves to form a cover or bottom to the Receiver, while the arm is used as a Single Loader.

PROFESSIONAL NOTES.

These articles have not been read before the Institute, but are inserted by direction of the Executive Committee.

DIFFERENT TYPES OF CIRCULATING PUMPS FOR SURFACE CONDENSERS.

Few who have experience in the care and management of the old-fashioned circulating pumps driven directly from the steam piston rods, and with independent pumps as now applied, will hesitate in their preference for the latter.

The following comparison of the two systems as applied to the Alaska and Despatch may be of interest to some:

	Alaska.	Despatch.
Number of cylinders	2	2
Diameter	50″	33″
Stroke of Piston	42″	33″
Diam. of circulating pump	18″	Centrifugal, driven by indep'd't steam cyl. 12 in. di. and 8 in. st., 130 re. per m.
Stroke " "	42″	
Indicated horse power	523.8	542.1
Pressure at release, (absolute)	13 lbs.	17 lbs.
Mean back pressure	3.25	6.2
I. H. P. of pump cards	35.09	
" " independent engine		2.29
Per cent. of power absorbed by circulating pump	6.69	0.41
Square feet of condensing surface.	2465	1165
Cross area through tubes	188sq in	198 sq. in.
Temperature of injection	64°	45°
Temperature of discharge	84°	79°
" " feed	136°	120°
Foot lbs. of work expended on pump per thermal unit removed.	5.93	0.42

In the case of the Alaska, only the work done on the water is accounted for, so that really 35.09 I. H. P. should be increased to about 42. I. H. P., which would show still worse for the Alaska. On the other hand the Alaska was running at half power and the Despatch at full power.

CHARLES H. MANNING,
P. A. ENGINEER, U. S. N.

A NEW SPEED INDICATOR.

The speed indicator consists of a combination of three independent parts, viz. an instrument for creating a vacuum, a long flexible tube for communicating the vacuum to a gauge on deck, and the vacuum-gauge itself. The instrument for creating the vacuum (in itself old) is founded on the principle discovered by Bernoville in the sixteenth century, that water flowing through a cylindrical mouthpiece contracts its vein at a distance of about one-half the diameter of the cylinder from its entrance, and that at the point of greatest contraction a partial vacuum is produced. Further, that the vacuum varies as the square of the velocity of the water, and that it is immaterial whether the water flows through a stationary tube, or whether the tube is hauled through the water, the latter remaining stationary.

To obtain a more perfect vacuum, I use, instead of an ordinary cylinder, a combination of conical tubes about one foot long, made of sheet brass, shaped like a dice-box, and so constructed that a high velocity is produced at the contracted part. Around the circumference of the tube, at equal distances from each other, are three small brass pipes which enter the vacuum instrument at the most contracted part, whence they converge symmetrically to a point some distance in front of the mouth of the tube and in the prolongation of its axis.

The vacuum instrument is kept at a mean depth in the water by means of a float, which is towed by a wire leading from a collar on the flexible tube; the float is over the instrument and connected to it by means of a wire. The flexible tube is of hard rubber, three-eighths inch external and one-eighth internal diameter. To protect it from chafe and wear, fine copper wire is braided over the outside and blended with it by heat. Through the centre is rove a stout copper wire making fast to the ferules by which the sections of the tubing are joined together; by this means the tubing is made as strong as an ordinary log-line. The length of the tubing varies with the vessel: for yachts fifty feet are required; for boats, fifteen feet; for small steamers, one hundred feet, and for large steamers, two hundred feet. The tubing may be astern or alongside; but it must be rigged out from the side so as to be clear of the eddies.

The flexible tube fits over the top of the gauge on deck; the latter may be of any type, but the mercurial gauge is preferable for many reasons. The glass tube of the mercurial gauge is drawn down to a very fine opening to throttle and regulate the fluctuations of the mercury; the gauge is suspended like an ordinary sea barometer, and is fitted so that when not in use the tube is protected from injury.

In all instruments hitherto, in which the speed has been indicated by a vacuum, the vacuum instrument has been rigidly connected to the vessel. The objections to this are that the ship by friction always carries along with it a large body of water, and in rolling the tube is carried to different depths; both causing incorrect indications. There is also the practical objection that if the instrument becomes fouled it is difficult to get at it to clear it.

In using the indicator, the vacuum instrument is thrown overboard and the flexible tube paid out from a reel on deck; when it is out to its full extent, the strain is taken by a wire extending from a collar on the tube near the rail to a stanchion on deck. The resistance offered by the instrument being small, it does not come to the surface, while its conical opening and the flow of water through it serve to steady it. The tube is then connected to the gauge, when the mercury will immediately rise till it attains a height due to the speed of the vessel through the water.

When tried on board the Alarm, with a speed of eleven and three-quarter knots (the highest attained), the height of the mercurial column was nine inches; the fluctuations amounted to only one quarter of a knot at the most, and generally the mercury was steady. No doubt with better apparatus the results will be improved. The higher the speed with the same fluctuations, of course the smaller the error; on account of the increased distances on the scale. In smooth water the instrument will show a speed of one knot, equal to a height of one-eighth of an inch of mercury. The advantages of its use in sailing vessels are especially apparent, as the effect of any sail may be known in a moment.

Chief Engineer Isherwood, in a personal report to me, signed also by Chief Engineers Zeller and Magee (the experimental board), says, "We are of opinion that this instrument, when properly constructed and adjusted and correctly graduated, will give the vessel's speed reliably and to a closer reading, owing to the sensibility of the mercurial column, than any of the patent logs known to us. It is so simple that its use may be entrusted to the least intelligent, and there is nothing in its construction liable to derangement. The above statements are warranted by the practical test to which we saw the instrument subjected on board the Alarm during the experimental trials of that vessel in the Hudson river."

W. S. HOGG,
ENSIGN, U. S. N.

REVIEWS.

No publication will be noticed under this head, unless a copy, to be placed in the Institute library, is sent to the Corresponding Secretary at Annapolis, Md. Reviews must be signed by the writer.

CAPTAIN ERICSSON'S SUBMARINE TORPEDO SYSTEM. *American Machinist, Sept.* 24, 1881.

In arriving at his present torpedo system Capt. Ericsson seems to have advanced through the stages of a compressed air motor, directable torpedo, an overthrow diving projectile, to the true submarine gunpowder projectile, one which, as regards means of projection, for years has been the dream of torpedo men.

He seems to have satisfactorily proved that the gases of exploded gunpowder can be used to eject a torpedo, and that the torpedo shall have a practical velocity through the water—enough at short range to strike a rapidly moving ship's hull. The method is so simple and natural that it is only by remembering the difficulties that have baffled others when working in this line that we can appreciate what has been done.

The Whitehead is perhaps the only auto-mobile torpedo that can be said to have had a career; and that is a complicated machine, carrying its own power and utilizing it through engines, propeller, etc.; the power must be stored through use of an air compressor, and must be worked off properly through the engines. Ericsson stores enormous power, always ready for application, in a powder tank in the magazine and brings it into use by applying fire. When the Whitehead torpedo is fitted with a cable and electric steering gear, as in the one intended for cruising between the forts at Spithead, it is no longer a true auto-mobile, but a directable torpedo, and it must then compete with the Lay and Scott-Sims, and others of the class.

But, considering both the Whitehead and the Ericsson as projectile torpedoes, the question arises, can the Ericsson do all that is claimed for the Whitehead? To this we must answer that we don't know;

but this we do know, that the Destroyer, steaming seventeen statute miles per hour, with a powder charge of twelve lbs. prismatic, fired its torpedo through three hundred and ten feet of water in three seconds, the length of the projectile being twenty-five feet and six inches, diameter sixteen inches, and weight, including explosive charge, fifteen hundred pounds; and retained a large safety margin as regards pressure in the chamber of its peculiar-looking gun. When these points were determined, Capt. Ericsson "was glad to terminate his experiments on account of the great risk an individual runs who ventures to experiment with guns and gunpowder without governmental authority, thereby exposing human life on his own responsibility."

He does not propose to stand off at long taws for torpedo work, but to run as close to the enemy as he possibly can—three hundred feet—and at the same time avoid ramming; his idea seems to be to close, try a torpedo shot, back, hard over helm, go around and try again if unsuccessful at first; and this is one of the best points of the system—the ease with which the gun can be reloaded for another shot. The torpedo room of the Destroyer takes nine projectiles, which can be placed in the gun and fired in quick succession.

At first glance at the system as shown in the *American Machinist* of September 24th of the current year, the idea that the firing pin of the fuse must push through the temporary valve or tompion while it is in the muzzle of the gun is rather disagreeable, especially if one make a personal application and imagine himself in the pilot-house over the gun when it is fired; but upon looking into the construction of the fuse and tompion, and considering what a large safety margin there may well be between the power needed to force off the india rubber covering of the firing pin-hole and that needed to compress the spiral spring whose duty it is to keep the pin clear of the primers, the sense of danger diminishes rapidly. It may be considered axiomatic that in all torpedo work one takes chances; but this chance of disaster through premature explosion in the gun seems really very small. The tompion enables the torpedo to start in air instead of in water—a very apparent advantage; but the air must be greatly compressed as the projectile moves forward; and it would perhaps force out the tompion before the firing pin reached it, if the distance traveled through were greater.

The familiar example of bursting a gun-barrel by placing a paper wad in the muzzle and loading with an ordinary charge, tells us by comparison what an enormous pressure there would be in the bore

did not the projectile so nearly fill it. Under the present conditions, experiment has shown that this pressure is not inordinate. From the arrangement of the powder charge by central suspension in the large chamber we should expect the small pressures that as matters of fact are found to exist during firing—small as compared with those of super-marine guns, but sufficient to give the huge mass of the torpedo an initial velocity of one hundred feet per second.

In looking through the Destroyer one is impressed by her beautifully compact four-piston rod, one thousand H. P. engines, fitted, of course, with that favorite of Ericsson, an independent air pump; and with the strength and simplicity of the hydraulic steering gear; the small wire wheel ropes have only to work an ordinary three-way cock between two pumps whose function it is to work the rudder, which has no rudder-post head to be shot away.

The man at the wheel sees the object of attack through a sight port cut through the armor at two feet above his head, a pair of inclined mirrors putting an extended field of view under his eyes, and has within reach speaking tubes to the engine and torpedo rooms, as well as the electric firing device.

Realizing its speed, the destructive power it possesses, its defensive power by submersion and by the inclined armor forward, the Destroyer would seem to be rather a comfortable vessel to fight in—comfortable, at least, as torpedo boats go, apart from the fire of the ship attacked bows on, which might be endured for the time necessary for a close. The combination that might make a person aboard her more or less uneasy, however, would be that of other torpedoes, auto-mobiles, projectiles, and even spars in case of closing too much, with plunging machine-cannon fire from an unattacked ship on the quarter.

To a person curious in ordnance details it would be interesting to know what decided Capt. Ericsson in adopting a square lug breech plug instead of the French fermature, and why he has no stop to determine the withdrawing position of the plug; while a seaman might wonder just how, in a sea-way, he was to handle, whip over the side, and ship in their beckets under the bow, the muzzle-loading guns proposed for a ship not provided with a submarine gun in its keelson.

Wm. W. Kimball, Lieut. U. S. N.

November 10, 1881.

BIBLIOGRAPHIC NOTICES.

ASTRONOMICAL REGISTER.

JULY, 1881. The visitation at the Royal Observatory, Greenwich.

The Astronomer Royal in his report states that the American extension of longitude carried on under Lt. Comdr. Green, U. S. N., to which reference was made in the last report, will be most useful for the transit of Venus in 1882.

BUREAU OF EDUCATION.

Circular of Information, No. 6, 1880.

From this, a report on the teaching of Chemistry and Physics in the United States, the following extract is made (pp. 87 and 88):

"Since the Naval Academy is an institution different in kind and in special purpose from any of the other schools which we have to consider, a few words just here may not be out of place concerning the usefulness of science to a naval officer. It was not until years after the establishment of the Academy that physics and chemistry were given much weight in the course of study; and although, through force of circumstances, these branches have brought themselves more and more into prominence, there is yet in the minds of many naval officers only a vague idea of their value, and in some cases even a strenuous opposition to their growth in the academic curriculum. These studies are also opposed by those who regard a man's attainments in mathematics as a true measure of his ability, and who consequently look with contempt upon natural science except when it admits of mathematical discussion. It would be easy to point out the fallacies which underlie these sources of opposition, but such an argument is outside the scope of this report. The purpose of the writer is, not to show the relative value of the studies in question with reference to other studies, but their actual utility to the naval officer.

"The commanding officer of a ship is the ruler of a community, the head of a household. Within the narrow walls of a vessel inclosing hundreds of men are contained all their food and water, all their clothing, and all the materials for the pursuit of their various callings. There the men eat and there they throw off their effete material, and the care of all depends upon the commander. He is responsible for the purity of their food and for the hygienic condition of their surroundings. Surely a familiarity with the results of modern scientific investigations cannot but be useful to him. Again, the instruments upon which he depends for his safety, the sextant, the compass, the chronometer, and the barometer, are purely physical instruments, and a knowledge of the principles which their construction and use involve must be of as great value to him as an acquaintance with the way in which the formulas and the tables that he employs in his calculations were deduced. If we consider the armament, we find that here again the progress of modern science is such that the intelligent officer must become familiar with her results. Improvements in the gun and in the torpedo can only be effected rationally by the scientific officer, and without a knowledge of chemical science the new explosives cannot be comprehended, or even used without great danger.

"Furthermore, naval officers are at different times on duty in the Naval Observatory, as observers, rating chronometers or correcting compasses. At the

Hydrographic office they compile and compare thermometrical, barometrical, and hydrometrical observations, and observations on the winds, tides, and currents. They take the records of soundings and of surveys, and make charts of the ocean, bottom and surface, for the whole world. They are attached to the Coast Survey, doing all the varieties of work in which the survey is engaged; to the Bureau of Steam Engineering, designing the machinery for our ships; to gun foundries, superintending the construction of ordnance; to gunpowder mills, supervising the manufacture of powder. They are detailed in boards to inspect food, fuel, materials, and clothing. In every one of these occupations a knowledge of either physical or chemical science is advantageous, and in some cases absolutely necessary."

COULBURN'S UNITED SERVICE MAGAZINE.

JULY, 1881. Some vessels ancient and modern. The training system in the German navy (translation.)

SEPTEMBER. The navy.

EDINBURGH REVIEW.

JULY, 1881. The storage of electricity.

FICTION.

VOL. 1, No. 10. The end of New York.

A clever little story upon the *Battle of Dorking* type, by an ex-naval officer whose identity is indicated by his assumed name—Bentley Parker. A Spanish consul landing in New York is arrested, through a mistaken identification, for extradition to Chile. After the usual interchange of diplomatic notes, war follows. Two engagements at sea take place; then a Spanish fleet of armored vessels appears off Sandy Hook, forces an entrance into New York harbor, and levies an indemnity of fifty millions dollars upon the cities of New York, New Jersey, and Brooklyn. Before the money is paid, by the aid of a storm and of the Chilian armored fleet of three vessels, the Spanish fleet is destroyed and New York relieved.

The article has had a wide circulation throughout the country, and is likely to do good in calling popular attention to the weak state in which our coast and naval defences have fallen.

FRANKLIN INSTITUTE JOURNAL.

JULY, AUGUST, 1881. Experiments with screw propellers.

SEPTEMBER. Condensing vs. non-condensing engines.

INSTITUTION OF MECHANICAL ENGINEERS.

TRANSACTIONS, APRIL, 1881. On riveting, with special reference to shipwork.

MILITARY SERVICE INSTITUTION OF THE U. S.

JOURNAL, VOL. II, No. 7.

The Pratt Range Finder. This ingenious instrument, weighing about one ounce, was invented by Lieutenant Sedgwick Pratt, U. S. A., for measuring distances. It consists of an upper and lower plate, triangular in shape, parallel to each other, the apexes of the plates being connected by a vertical post, and the bases by a light framework called the back, in which there is an opening for the line of sight to pass through. Above and below the aperture in the back is a mirror, and hinged to one side of the back is a second mirror fixed at an angle of 45° with the first one and extending down from the upper plate to the aperture. To the other side of the back is hinged a third mirror, fixed at an angle of 43° 34′ 7½″ with the first one, and extending up from the lower plate to the aperture. These two mirrors converge at the vertical post connecting the apexes of the upper and lower plates, and are adjusted by means of screws in the post.

To measure a distance between two points A and B, stand at A and observe B through the opening in the back, and observe the reflected image made by

the upper mirror and the one in the back, fixed at an angle of 45° to each other, then move with the instrument in a direction perpendicular to a line drawn between A and B, to a point C where the point A, seen by means of the lower mirror and the one in the back, fixed at an angle of 43° 34′ 7½″ to each other, coincides with the point B as seen through the aperture. The angle BCA=87° 8′ 15″ and the angle ABC=2° 51′ 45″ and AC, its tangent, will be one-twentieth its radius; hence, if we measure AC and multiply by twenty, the product will give us the distance between A and B. This little instrument has given excellent results in practice.

The Marvin Shell Extractor, a device for removing a headless shell from a breech-loading small arm. It consists of a slotted steel tube, flanged at one end, and provided with an expansion pin for spreading the tube after insertion in the shell. The extractor is inserted in the shell and is expanded by closing the breech of the gun, so that when the breech is again opened the shell is withdrawn. The following points are claimed in its favor: it is light, simple, strong, certain of action, and can be used by the rawest recruit.

MITTHEILUNGEN AUS DEM GEBIETE DES SEEWESENS.

Nos. IV and V, 1881. Experiments for improving the construction and use of steering compasses. Resumé of German and foreign patents. Demonstration of the law of relative velocities due to the form of the wave arising from the resistance of the ship. The war in South America. An experiment for determining the local mean time at sea without the use of goniometry, by observations on the rising or setting of stars. A method of signaling by which a ship's course is accurately marked. The electric light for coast lighting. Austro-Hungarian navigation in foreign countries. Notice of the English, French and Italian ships in service. Budget of the Russian navy for 1881. The use of steel in the construction of merchant ships. New order concerning uniform regulations for signaling, to prevent accidents at sea. The outline of the Atlantic ocean. The classification of iron and steel. Statistics of ships lost in 1880. Directions for preventing collisions at sea.

Nos. VI and VII. Improvised torpedoes and defences to ward off torpedo assaults. Opinions upon the education of machinists-in-charge for the imperial navy. Biographical sketch of Lt. Carl Weyprecht. Method of arranging two dynamo-electric machines for getting a combined current. Continuation of the study of the chronometer. A system for testing the speed of ships. The Russian torpedo boat Batum. Ships of the German navy in service. Budget for the Swedish navy for 1881. Krupp's 26 cm. cannon of 26 caliber's length. The English navy. Budget of the French navy for 1882. The Corinthian canal. Scientific expedition to Lapland. Third international geographical congress. The classification of iron and steel.

Nos. VIII and IX. The armored coast defences of England. Manufacture of sail cloth. New armored ship for China. Torpedo boat for China. New gunboats for China. Trial of the speed of the German armored corvette Württemberg. The English torpedo ram Polyphemus. New classification of the vessels of the French navy. Naval brass. Electric lighting on ships. Dr. Fleischer's hydromotor ship. Physical researches in the Adriatic and Sicilian seas during the summer of 1880—[a full and valuable paper].

MITTHEILUNGEN UEBER GEGENSTANDE DES ARTILLERIE UND GENIE-WESENS.

No. VII, 1881. Upon the material for the construction of magazines and laboratories for explosives.

Nos. VIII and IX. Upon Boutney's and Foucher's method for the commercial manufacture of dynamite.

NORTH AMERICAN REVIEW.

Aug. 1881. A militia for the sea, by Mr. John Roach.

The author proposes "to show our present naval condition, the costly consequences of naval weakness in the past, the urgent necessity to provide naval

protection in the future, and to suggest a plan to provide this protection in the most economical and effective way,—a way at once profitable to the government and promotive of our commerce." After discussing the various points mentioned, Mr. Roach submits as his plan, "the construction of one hundred fast iron screw steamships, to be divided into five classes. All to be engaged in the foreign trade." The five classes to be composed of vessels of from four thousand to two thousand five hundred tons, with a speed of sixteen knots for the largest class and of fifteen knots for the others. The government is supposed to appropriate three to five million dollars yearly as subsidies to the lines employing these steamers for carrying the mails and opening new markets to our productions. Mr. Roach knows one man "from whom one quarter of the amount needed to construct the whole fleet could be procured at once on the following basis: The government to advertise . . . for the building of such steamers, to run on such service for a term of ten years, these ships to conform in speed and tonnage to those above classified, to be built on plans approved by the government limiting the mail service to a certain amount per mile according to the speed and tonnage, to be given to the lowest bidder." A plating of steel armor nine inches thick and nine feet deep is kept ready, and in case of war the vessels, in thirty days, can be converted into swift armored cruisers at a small cost. "One of the four thousand ton class would require a crew of three hundred and fifty men," and "would carry independent of small arms, torpedoes, ammunition, and provisions for her crew, three thousand tons of coal, which would keep her at sea four months," without the aid of sails.

In conclusion, Mr. Roach says: "If anybody has a better plan than mine to propose, let him propose it. Something ought to be done for our navy at once. The present plan is intended to build up a navy and revive our carrying trade at the same time. Such a fleet might well be named the militia of the sea."

REVISTA GENERAL DE MARINA.

JULY, 1881. Notes on electricity (continued). Compasses and their adjustment in iron ships (translation). Resumé of the accidents in Russia in handling torpedoes (translation). Reckoning of time and the choice of a prime meridian. The Inflexible (translation). The corvette Aragon. Chain fastenings for securing a battery.

AUGUST. Shell rooms. Notes on Japan. Studies of spectrum analysis. Glances at the war between Chili and Peru (translation). The German navy. Dictionary of the English armored vessels (translation).

SEPTEMBER. The interior of the earth. Steam generators. The corvette Aragon.

REVUE DES DEUX MONDES.

JULY 15, 1881. The war in the Pacific—the causes, the engagements at Iquique and Point Angamos, and the capture of the Huascar.

SEPTEMBER 1. New Zealand and the small islands adjacent. The voyages and reports of Captains Dumont d'Urville, Laplace, du Petit-Thouars, Fitzroy, Wilkes, and James Ross.

REVUE MARITIME ET COLONIALE.

APRIL, 1881. The sea fisheries. The value of K in the range formula. General table of contemporary naval history. With this paper, Captain Chabaud-Arnault brings his extremely valuable record of the principal naval events of recent years to an end. It includes desultory naval operations in Mexico, in Japan, in the war between Germany and Denmark, between Peru and Chile, between Austria and Italy, between Paraguay and Brazil, and the French expedition to Corea. A general view of the navies of the maritime powers in 1868 is then given. The navy of the United States is classed as among those of second importance, with those of Spain, Holland, Sweden, and Turkey. The author then gives the inferences he draws in regard to the defences of coasts, the construction and armament of ships, torpedoes, the types of armored vessels, naval artillery, and unarmored cruisers. From the actions in the recent war in the United States,

the author concludes that land batteries, even when well constructed and fortified, are powerless, unaided by torpedoes and light draft rams, to prevent the forcing of a passage by steam fleets. He shows that it was during this war that the whole system of naval warfare was revolutionized by the introduction of rams, armored turrets, and torpedoes, and in conclusion discusses the changes brought about in naval tactics by the introduction of these novel engines of destruction.

The tactics of ramming. English colonies, Victoria. Dictionary of the Russian armored vessels. Marine steam engines.

MAY. Lunar distances. Martinique. Naval tactics. The royal naval academy from 1775–77. English colonies, South Australia. Dictionary of the Turkish armored vessels.

JUNE. Dictionary of the Austrian armored vessels. Admiral Duperré and the Algerian expedition. Martinique. Compensation of the compass by means of soft iron. English colonies, West Australia. Research into the effect of the curvature of screws.

ROYAL GEOGRAPHICAL SOCIETY. PROCEEDINGS.

JULY, 1881. The annual address on the progress of geography.

In connection with Arctic adventure, the president, Lord Aberdare, mentions the journey of Lieutenant Schwatka, U. S. A., also the voyage of the Corwin in 1880 in search of the Jeannette. He adds that the Helen and Mary, under command of Lieutenant R. M. Berry, U. S. N., is to start on a voyage for the same purpose, and says: "I sincerely trust that before the close of the coming season we shall receive news of the Jeannette's safety, and that Lieutenant De Long and his gallant companions have been restored to their friends, after having added largely to our geographical knowledge."

ROYAL UNITED SERVICE INSTITUTION JOURNAL, No. CX.

The pumping arrangements of modern war ships. Study of the tactics of naval blockade as affected by modern weapons. In this paper, Captain Samuel Long, R. N., after giving a short historical retrospect, discusses naval blockades, "instituted against fortified commercial ports to stop commerce with the enemy and prevent the issue of privateers or war ships." He finds that "the proceedings of the federal navy on the coast of North America during the war of 1861–5 furnish the most conspicuous example of this kind." In conclusion he says: "To sum up, then, it appears that where it is required to institute a blockade, the best mode to render it efficient is to seize an island or point commanding the channel, and lay down electro-contact mines. Where this is impracticable, but the channel narrow and extending far from land, to lay down mines resting on a floating base. Where neither is possible, organize a suitable squadron, with numbers of light swift vessels, resting on a favorable base, and after practice and with a fair proportion of time off duty, it is probable that a fairly efficient blockade would be maintained, and that squadron would find it more difficult to escape unperceived than formerly." Tables appended give the coal consumption, etc., of torpedo boats, and the probable coal consumption of a blockading squadron.

Naval tactics. Vice Admiral Dowell, C. B., furnishes a paper on this subject, in which he treats of naval tactics in connection with squadrons composed of ironclad ships. In doing this he considers—(*a*) *The Composition of the Squadron.* He advocates the maintenance of three squadrons of eight or ten ironclad ships each. Every squadron should have attached to it two fast lookout vessels, and two fast unarmored frigates or corvettes, taking no active part in any engagement, but prepared to assist the crews of any disabled or sinking ship of friend or enemy. The etiquette of the present day should be, that vessels will not be molested in such work unless they in any way join in the action. Battles will in future be fought at such a speed that any vessel disabled will soon be left behind, and there would therefore be no temptation to disturb the frigates in their endeavors to save life. The ships should be painted alike, with a dis-

tinctive mark, such as a white streak, to distinguish them from the enemy. Also the mastheads of all ships should be painted alike, with a distinctive mark in addition to the vane now ordered to be carried. A water-line, visible as the smoke lifted, would be an advantage, black and white being the best colors for this purpose. (*b*) *The Armament of the Squadron.* Of the three weapons, the ram, the gun, and the torpedo, the two former are placed nearly on a par, whilst the latter is considered an an auxiliary only. The gun and ram are placed so much on an equality, because of the range of the former and its capability of being trained. An enemy cannot escape a well directed broadside, whereas it is possible by the use of the helm, by increasing or decreasing the speed, to avoid the ram, though the latter when it takes effect is the deadliest weapon of the two. In the use of the ram the endeavor should be to gain sufficient room abeam to turn with the helm eased, and a distance of one and a half cables is suggested for this purpose. Though guns of the present day have a range of several miles, their effectiveness is limited by the armor they have to pierce and the angle at which they must strike. The author therefore recommends that fire should be reserved, except on special occasions, until the distance is less than one thousand yards, and the bearing as nearly as possible at right angles to or on a line with the adversary's keel. In case of an enemy endeavoring to escape, bow fire would be of use at greater distances, to damage if possible her steering gear. In regard to the method of discharging guns, electric firing should be used at all times when a broadside is required to be delivered at ships rapidly passing, or when the ship herself is rapidly turning. Under other circumstances it would be an error for the officer at the director to assume the functions of officers in the battery and the captains of the guns. The use of the Whitehead torpedo should be limited to four hundred yards, and with respect to spar torpedoes the author considers them a very doubtful weapon for ironclad ships. (*c*) *The Organization of a Squadron.* In organizing a squadron of mixed broadside and turret ironclads, it would be desirable to place the ships of each class in separate divisions, though if unevenly divided there can be but little reason why they should not work in the same division or group. Ships throwing the heaviest weight of metal should be leaders of divisions, subdivisions, and groups, even though these ships are commanded by junior captains. The author speaks strongly in favor of the group system adopted in the English service, and of the imperative necessity of officers possessing a thorough and practical knowledge of the signal-book. The squadron should steam in regular order, except at night, in crowded waters, or in heavy weather. The efficiency of a squadron depends upon the ships being in station. With the ships in station the squadron is a machine which can be moved at once in any direction with perfect safety; but with ships out of station it is an irregular mass, which an admiral would be unable to move for fear of accidents. From seven to eight knots is considered the speed most advantageous for engaging an enemy. This allows a sufficient margin for increasing or decreasing speed to effect or avoid a ram. Ships should turn the same way to ram, and when the question is open, an advantage would be gained by attacking to leeward, in order to avoid the smoke that hangs so long on the lee side. (*d*) *The most effective Method of bringing the Squadron into Action.* The author proposes four plans of attack, viz., for an enemy in single column; in line; column of pelotons (equilateral groups); and in pelotons abreast. Case I. A's squadron of six ships sights an enemy's squadron B, also of six ships, at a distance of four miles, in single column, steering a nearly opposite course. A's admiral decides to attack in columns of groups in quarter line, attacking B on starboard or port side as he may think most advantageous. Case II. The enemy's squadron is observed to be in line, A's admiral forms groups abreast, leaders four cables apart. Case III. The enemy's squadron appears in column of pelotons. A's admiral decides to attack on B's starboard side, in column of groups in quarter line, as in case I. Case IV. The enemy is found to be in pelotons abreast (line), steering toward A's squadron. A's squadron in group formation abreast, steers so that its leaders of groups shall pass half a cable abeam of B's right flank ships. The author calls attention to the immense importance of exercising squadrons.

To make a squadron thoroughly efficient, the admiral must have confidence in his captains, the captains in each other, and the lieutenants in their brother officers, and no portion of the country's money is put to better interest than that spent in training naval officers and men to fight its ironclad squadrons.

NO. CXI. The further development of the Thornycroft torpedo vessels.

Mr. Jno. Donaldson, of Messrs. Thornycroft & Co., gives an account of the progress made in the improvement of the torpedo boats up to date. There seems to be no radical change or marked improvement in their construction or equipment. The larger class of boats, which are intended to act independently, and which are expected to be able to keep the sea under ordinary circumstances, have been gradually increased in size, while the smaller class, which have to be hoisted in and carried by vessels, remain of about the same dimensions. Several improvements in the details of the construction of the boats are noted, among them an attachment to the boiler by which the water may be heated by steam conveyed by a hose from the vessel's boilers. Steam is conveyed in like manner to a fan in the boat, accelerating the fires by an artificial draft. This arrangement was tried in competition with the Herreshoff boiler, but the latter was found to be able to get up steam rather more quickly. Its success however was considered sufficient to warrant its adoption in all boats then in process of construction. The turbine wheel is being tried as a hydraulic propeller, but the results with reference to speed are not given. The Herreshoff boiler is also being tried in a few of the new boats. An apparatus, patented by Mr. Thornycroft, is being applied to the boilers of the locomotive type for preventing accidents to stokers, in the event of the bursting of a tube or other sudden leakage of steam into the interior of the boiler. The larger boats, in addition to the Whitehead torpedo, which may be considered as their proper armament, are supplied with a spar torpedo and a machine gun. They are also constructed with a ram bow, to give them additional means of attacking, and defending themselves from other boats.

A NEW NAVIGATIONAL SOUNDING MACHINE AND DEPTH-GAUGE.

In his opening remarks the author, Sir Wm. Thomson, LL. D., F. R. S., says: "The objects sought to be attained by this new instrument are twofold: first, to protect the wire from rust more completely and more conveniently; and secondly, to supercede the necessity for using the chemically prepared tubes, one of which had to be used every time a cast was taken." Both machines, the old and the new, are intended for the same purpose, *i. e.* to obtain soundings to depths not greatly exceeding one hundred fathoms, without stopping or diminishing the speed of the vessel. The points in common may be stated as follows: A reel containing a coil of pianoforte wire is mounted on standards, and has a circumferential V-groove for receiving a "friction-rope" to operate as a controlling brake when wire is being paid out, the amount of frictional resistance thus applied being correctly adjusted by means of a weight suspended from the free end of the rope. A register shows the number of revolutions made by the reel, but the true depth is obtained from a pressure-gauge sent down at each cast. The essential points of difference are as follows: The necessity for removing the reel from its bearings in order to place it in the tank of lime-water used as a preservative of the wire has been obviated. The new reel and standards are mounted upon the tank when in use, and it is only the work of a few seconds to dip the whole machine bodily into the tank between casts. Although both the old and the new gauges are dependent for their indications on the compression of a volume of air by hydrostatic pressure, they differ widely in construction. The old gauge consisted of a plain glass tube closed at one end and coated inside with chromate of silver. It was inclosed in a metal case and lowered with the open end downwards. The change in the appearance of the chemical coating showed the height to which the water had penetrated the tube, and the application to the tube of a graduated metal scale, made for the purpose, gave the number of fathoms of depth reached by the gauge.

In the new device, which the inventor styles the "*Triple Depth Gauge*," he has followed the general features of the Ericsson gauge—patented in 1827—in having two communicating chambers, one being used as a receiver and the other as a reservoir; but improvements have been made to insure that the indications of the instrument shall not be vitiated by water entering or leaving the reservoir during the violent usage inseparable from an ascent made while the ship has headway. To prevent the egress of water from the reservoir he uses a guard tube projecting into the latter in a manner similar to that employed in the non-spilling ink-bottle. This device proves entirely efficacious so long as the reservoir is not more than half full. He combines in a single case or holder a set of three gauges which differ from each other only in the relative capacity which the receivers bear to their respective reservoirs. Each gauge is applicable to different depths, but their several capacities are so adjusted relatively to each other that the range of the instrument is continuous from eleven fathoms to one hundred and twenty-six and one-half fathoms. In the first gauge of the series the overflow from the receiver into the reservoir takes place at eleven fathoms; and at twenty-seven and one-half fathoms when that reservoir, being half full, is no longer to be trusted, the reservoir of the second gauge begins to receive an overflow, and so on. Over the open end of each *receiver* a piece of fine cotton cloth is tied. The wet cloth with light pressure is air-tight although permeable by water, hence during the ascent every drop of water is expelled from the *receiver* by the pressure of the expanding air before any air escapes, and the gauges come to the surface with the receivers perfectly drained of water.

SOCIÉTÉ DES INGÉNIEURS CIVILS. MÉMOIRES.

APRIL, 1881. The ports of Antwerp and Toulon.

JULY. Report of M. VINCENT on celluloid. Celluloid is a complex product formed by mixing nitro-cellulose with camphor. It is hard, elastic, transparent, and capable of taking a high polish. Its density is 1.53. We can, by adding to it various coloring matters in a pulverulent condition, give to it the appearance of ivory, ebony, coral, etc. It was discovered in 1869 by Mr. Hyatt, of Newark, New Jersey. It softens at about 80° C., and can then be readily moulded. It begins to decompose slowly at about 130° C., and very rapidly at higher temperatures. It can even be partially detonated between 130° and 140° C. We ought then to protect it from any considerable elevation of temperature and store it only in small quantities. The pyroxiline is made from cigarette paper of good quality by immersing it for twelve or fifteen minutes in a mixture of five parts of sulphuric acid of 66° and two parts of nitric acid of 42° B., at a temperature of 35° C. It is then washed, triturated to a paste and bleached with permanganate of potash, and then treated with sulphurous acid to remove the oxide of manganese, and finally washed. This substance mixed with camphor forms celluloid.

The use of dynamite in the destruction of bridges, by M. Brunet. The amount of dynamite to be employed depends upon whether we are to use it against pier or metal girders. In the first case where it is placed in bore holes, M. Brunet calculates the amount of dynamite to be used by formula (1), page 122, vol. VII, U. S. Naval Institute Proceedings. For the second case, where the dynamite is a cartridge to be placed in contact with the girder, he uses the formula $L=d^2$, given on page 140, vol. VII, Proc. U. S. Naval Institute. Several instances of the successful use of dynamite in the quantities thus estimated are cited.

BOOKS RECEIVED.

American Geographical Society. Bulletin No. 6 of 1879, and No. 5 of 1880.

American Institute of Mining Engineers. Papers read at the Philadelphia and Virginia meetings (26).

American Metrological Society. Proceedings, Vols. I and II. List of members.

American Society Civil Engineers. Transactions, June, July, August, 1881.

Ericsson's Submarine Torpedo System.

Fiction. Vol. I, No. 10.

Franklin Institute, Journal, July, August, 1881.

Institution of Mechanical Engineers, April, 1881.

Military Service Institution of the U. S. Journal, Nos. 6 and 7.

Mittheilungen a. d. Gebiete d. Seewesens, Vol. IX., Nos. 4 and 5, 6 and 7, 8 and 9 (3).

Moniteur de la Flotte, No. 43, 23d year.

North American Review, August, 1881; from Mr. C. P. Hewes.

Réunion des Officiers, Bulletin No. 44, 11th year.

Rivista Marittima, July–August, September, 1881.

Royal United Service Institution Journal, Nos. CX and CXI.

Société d. Ingénieurs Civils, Mémoires, April to August, 1881 (5).

Wörterbuch der Marine. Parts 1 to 9. By P. E. Dabovich.

Annual Report of the Light House Board, 1880.
Circular—Consumption of Oil.
Courtnenay's Automatic Signal Buoy.
Illumination and Beaconage of the Coasts of France.
Instructions to Light-keepers, 1881.
The U. S. Light House Establishment.

From Commander George Dewey, U. S. N., Naval Secretary Light House Board.

The following members have joined since the publication of the last catalogue.

Members. (24)

Ayers, J. G., Surg., Navy Department.
Blish, J. B., Midn., Constitution.
Briggs, J. B., Lieut., Naval Academy.
Caldwell, W. M., Esq., No. 1202 18th St., Washington, D. C.
Dougherty, J. A., Midn., Constitution.
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